JAN 9 1942

CAL. ROOM
LIBRARY
OF ...

SCIENCE

NEW SERIES
VOL. 95, No. 2454

FRIDAY, JANUARY 9, 1942

SUBSCRIPTION, $6.00
SINGLE COPIES, .15

Ready Soon!

A New Textbook by Wertheim

Introductory Organic Chemistry

By E. Wertheim, Ph.D.
University of Arkansas
Illustrated. 482 Pages. Glossary, $3.00

This new textbook has been especially planned to meet the needs of students in home economics and agriculture. The introductory chapter is devoted to the orientation of organic chemistry to other sciences and to daily life. The relationship of organic chemicals to agricultural products is stressed. The structure of various typical compounds is worked out to show the value of the graphic formulas and how they are determined for simple compounds. Graphic formulas are liberally used. The subject of correct nomenclature receives adequate treatment in the various chapters and a helpful list of name endings is given in the appendix. Equations are repeated when desirable as an additional teaching aid. Summaries, review questions and numerous specially prepared charts are included. The vitamins are given careful study; formulas for vitamins known up to September 1941 are included. Fats, carbohydrates and proteins are given adequate treatment in preparation for courses in nutrition and biochemistry. A glossary of topics of inorganic chemistry giving clear definitions of inorganic facts and theories is included in the Appendix as an aid in the review of general chemistry which most students need while studying the organic course. There are four chapters in biochemistry which take up digestion, metabolism, heat production and loss by the body, and types of food. Thus the book ties up with inorganic chemistry on one side and with biochemistry on the other. There is a section in the appendix on stain removal from fabrics which should be of value in home economics work. The book is well illustrated with views of industrial equipment, applications of organic products, animals with vitamin deficiency diseases, models (both expanded and Hirschfelder type) of organic molecules, human digestive system and numerous line drawings.

THE BLAKISTON COMPANY

PHILADELPHIA

Science: published weekly by The Science Press, Lancaster, Pa.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

A New Publication . . .

THE WHITE-CROWNED SPARROWS

(ZONOTRICHIA LEUCOPHRYS)
OF THE PACIFIC SEABOARD

ENVIRONMENT AND ANNUAL CYCLE

by

BARBARA D. BLANCHARD

University of California Publications in Zoölogy

Volume 46, No. 1, pp. 1–178, plates 1–20
30 figures in text

Paper, $2.00

UNIVERSITY OF CALIFORNIA PRESS

Berkeley and Los Angeles

Send all communications to the Berkeley address

BROOKLYN BOTANIC GARDEN PUBLICATIONS

ECOLOGY

Botanical Editor: FRANCIS RAMALEY
Zoological Editor: THOMAS PARK

Established 1920. Quarterly. Subscription, $5 a year for complete volumes (Jan. to Oct.). Back volumes, as available, $6 each. Single numbers, $1.50. Foreign Postage: 40 cents.

GENETICS

Managing Editor: M. M. RHOADES

Established 1916. Bi-monthly. Subscription, $6 a year for complete volumes (Jan. to Dec.). Single numbers, $1.25 post free. Back volumes, as available, $7.00 each. Foreign postage: 60 cents.

MEMOIRS

Vol. I. *Dedication Papers:* 33 scientific papers presented at the dedication of the laboratory building. 1917. 521 pages. $3.50, plus postage.

Vol. II. The vegetation of Long Island. Part I, The vegetation of Montauk: A study of grassland and forest. By Norman Taylor, June 11, 1923. 108 pages. $1.00, plus postage.

Vol. III. Vegetation of Mount Desert Island, Maine, and its environment. By Barrington Moore and Norman Taylor. 1927. 151 pages. $1.60.

Vol. IV. *Twenty-fifth Anniversary Papers.* 9 papers on 25 years of progress in botany (1910–1935); 5 papers on progress in horticulture. 133 pages. 1936. $1.35.

The Secretary, Brooklyn Botanic Garden
1000 Washington Ave., Brooklyn, N. Y., U. S. A.

ANATOMY OF THE NERVOUS SYSTEM

A Textbook from the Developmental and Functional Point of View, and Atlas of the Nervous System in Man

By OLOF LARSELL, M.A., Ph.D., Sc.D., Professor of Anatomy, and Dean of the University of Oregon Medical Graduate School, Portland, Oregon.

Each major division of the nervous system is considered in an individual chapter with gross anatomy treated briefly, and with main emphasis placed upon microscopic structure, the internal arrangement of the nervous elements and the functional significance of the parts described. Brief summaries of illustrative lesions are given at the end of a number of chapters. In addition to numerous superb illustrations appearing throughout the text, the book concludes with an Atlas and sections of the spinal cord and brain. Also in the Atlas are figures of the gross spinal cord and brain for orientation of sections. In all there are 341 figures, including 20 in color.

480 pages · 341 figures, 20 in color · Index bibliography · $6.50

D. APPLETON-CENTURY CO., 35 West 32nd St., New York

New (Fourth) Edition

TEXTBOOK OF EMBRYOLOGY

By HARVEY ERNEST JORDAN, M.A., Ph.D., and JAMES ERNEST KINDRED, M.A., Ph.D.

This distinguished, straightforward account of human development now incorporates the more significant of the mass of recent experimental and comparative embryological data. Particularly emphasized is the modern work on "evocators" and "induction." New descriptive material has been included throughout.

Chapters are now rearranged more logically. 78 new illustrations replace old ones or have been added. Literature references are now entered as footnotes and are also arranged alphabetically at the end of the book. An index of authors is a new and helpful feature.

626 Pages • 468 Figures • Index $6.75

SCIENCE

VOL. 95 FRIDAY, JANUARY 9, 1942 No. 2454

The American Association for the Advancement of Science:
Equilibrium Thermodynamics and Biological Chemistry: PROFESSOR GEORGE SCATCHARD 27

The Training of Biologists: PROFESSOR PAUL WEISS 32

Anniversary Address of the President of the Royal Society: SIR HENRY DALE 34

Obituary:
Frederick Hutton Getman: PROFESSOR EUGENE C. BINGHAM. *Recent Deaths* 36

Scientific Events:
Developments in Agricultural Research in Great Britain; Committee on Economic Trends of the Industrial Research Institute; The Cooperative Committee on Science Teaching; The American Fern Society; The American Philosophical Society; Officers of the American Association for the Advancement of Science 37

Scientific Notes and News 40

Discussion:
The Current List of Medical Literature: DR. CLAUDIUS F. MAYER. *The Duple—A Logarithmic Unit:* PETER SIMPLE. *Origin of the Japanese Waltzing Mouse:* DR. ERNST SCHWARZ 43

Scientific Literature:
Growth of Primate Literature Since 1800: PROFESSOR T. C. RUCH and PROFESSOR J. F. FULTON 47

Societies and Meetings:
The Tennessee Academy of Science: KENDALL E. BORN 48

Special Articles:
A New Protease from Bromella pinguin L.: DR. CONRADO F. ASENJO and M. DEL C. CAPELLA DE FERNANDEZ. *Particulate Glycogen:* DR. ARNOLD LAZAROW. *An Unidentified Virus which Produces Pneumonia and Systemic Infection in Mice:* DR. CLARA NIGG 48

Scientific Apparatus and Laboratory Methods:
Computing Scales for Calculating Percentage Deviation from Average Weight: DR. THOMAS I. EDWARDS. *Rapid Transmission Techniques for Stone-Fruit Viruses:* PROFESSOR E. M. HILDEBRAND 50

Science News 10

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

EQUILIBRIUM THERMODYNAMICS AND BIOLOGICAL CHEMISTRY[1,2]

By Professor GEORGE SCATCHARD

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SINCE science progresses by building block upon block, it is important to examine the structure from time to time to make sure that there are no badly fitted blocks, none which are being made to carry more than their proper capacity and none which might be made more useful. This is particularly true when thermodynamics, which is a vast and variegated structure erected upon the simple bases of the two laws of thermodynamics, is applied in biology and biological chemistry to systems so much more complicated than those in which its results have been tested by physical chemists. Yet such an examination is discouraged because we are so certain of the foundation on the two laws of thermodynamics as laid out by J. Willard Gibbs.

I see no reason to question the validity of the two laws of thermodynamics, even for vital processes, and the only mistake I know in Gibbs's great paper is a trivial typographical error. However, a close examination shows that the foundation we are using is not exactly the one laid out by Gibbs. A discussion

[1] Address of the retiring vice-president and chairman of the Section on Chemistry, American Association for the Advancement of Science, Dallas, Texas, December 29, 1941.

[2] Contribution from the Research Laboratory of Physical Chemistry, Massachusetts Institute of Technology, No. 498.

of the main ideas, without details and without mathematics, may bring out the differences and show how to minimize any difficulties which may arise from them.

From the fact that a system with constant energy which approaches equilibrium must increase in entropy, Gibbs derives two criteria of equilibrium. The first is that in a system in equilibrium there is no possible change which will increase the entropy at constant energy. The second and more useful one is that in a system in equilibrium there is no possible change which will decrease the energy at constant entropy. He then introduces a new function which he calls the potential or, more specifically, the intrinsic or chemical potential. He defines the chemical potential of a substance in a system as the derivative of the energy of the system with respect to the quantity of that substance when the entropy and volume of the system and the quantities of other components are kept constant.

The two chief characteristics of the Gibbs method are the consideration of the state of a system rather than a process, and the splitting of the consideration of the state of a complex system into the study of the chemical potentials of its individual components. The chemical potential has the characteristic properties of potentials such as the gravitational, electrical or magnetic potential. However, many of us are more familiar with it under other names or with related quantities which emphasize other characteristics. The partial molal free energy of a substance is its chemical potential per mole. The pH is the chemical potential per mole of the hydrogen ion divided by minus 2.3 RT. The osmotic coefficient of a solution is the chemical potential of the solvent divided by minus RT times the moles of solutes per mole of solvent. The activity of a substance is e with the chemical potential per mole divided by RT as exponent, and the activity coefficient is the activity divided by the concentration or by the mole fraction.

Gibbs's next step is to study equilibrium in an idealized system. I quote his own words:

> In order to arrive as directly as possible at the most characteristic and essential laws of chemical equilibrium, we will first give our attention to a case of the simplest kind. We will examine the conditions of equilibrium of a mass of matter of various kinds enclosed in a rigid and fixed envelope, which is impermeable to and unalterable by any of the substances enclosed, and perfectly non-conducting to heat. We will suppose that the case is not complicated by the action of gravity, or by any electrical influences, and that in the solid portions of the mass the pressure is the same in every direction. We will farther simplify the problem by supposing that the variations of the parts of the energy and entropy which depend upon the surfaces separating heterogeneous masses are so small in comparison with the variations of the parts of the energy and entropy which depend upon the quantities of these masses, that the former may be neglected by the side of the latter; in other words we will exclude the considerations which belong to the theory of capillarity.
>
> It will be observed that the supposition of a rigid and non-conducting envelope enclosing the mass under discussion involves no real loss of generality. . . . As for the other suppositions which have been made, all the circumstances and considerations which are here excluded will afterward be made the subject of special discussion.

Most of the important results associated with Gibbs's name are reached before the return to any of the excluded considerations, and the others are obtained while all but one of these considerations are still excluded. All his results are based on the assumption that there is equilibrium with respect to every possible change, and upon the count of the number of quantities necessary to describe the thermodynamic state of the system. At equilibrium and with the restrictions given by Gibbs, the energy of any phase may be expressed as a function of its entropy, volume and the quantities of its components. The partial derivatives of the energy with respect to these other functions, which are the temperature, minus the pressure, and the chemical potentials of the components, are independent of the quantity of the phase.

The phase rule needs nothing further, for it depends upon the number of independent variables and not upon the value of any of them. The application of the "Gibbs-Duhem equation," by which the chemical potential of one component can be determined if those of all the others are known, requires a knowledge of the variation of the chemical potentials with composition at constant temperature and pressure. The treatment of chemical equilibrium and of the distribution of substances between phases needs also a knowledge of the variation of the potentials with temperature and pressure at constant composition.

Equilibrium in these restricted systems is conveniently treated in terms of the Gibbs free energy, which may be defined as the sum for all the components of the products of the chemical potential by the quantity of the corresponding component. Then the conditions of equilibrium may be expressed as follows: the temperature must be the same throughout the system; the pressure must be the same except on opposite sides of a rigid membrane impermeable to at least one component; and the change in free energy must be zero for any possible change at constant temperature and pressure.

From statistical mechanics or from experimental observation, we know that the chemical potential of a substance at very low concentrations varies at constant temperature and pressure as RT times the logarithm of its concentration. Combined with the con-

ditions for equilibrium and the thermodynamic relations for the variation of the chemical potential with temperature and pressure, this leads to all the classical expressions for chemical or physical equilibrium. For many purposes it is sufficient to know these relations and the fact that the deviations have not become large at the lowest concentrations studied experimentally. Statistical mechanics, again confirmed by experiment, gives us this assurance and at the same time furnishes the tools for a quantitative study of the deviations. It tells us that the forces between molecules cause a variation in the chemical potential of an ion which starts out proportional to the square root of the ionic strength with a coefficient determined by theory, and a variation in the chemical potential of any substance which starts out proportional to the concentration of the added substance with a coefficient which is proportional to the interaction between a molecule of the added substance with one of the substance under consideration, corrected for the interaction of the displaced solvent. When the two substances are the same, the ratios of these effects to the ideal solution term are proportional to the square root of the concentration or to the concentration, and are also proportional to the ratio of the interaction energy to RT. In aqueous solutions, which are of primary interest in biological chemistry, much of this interaction is due to the displacement of water, and is thus directly proportional to the volume of the solute molecule. Other interactions depend upon the number of active groups and are also usually larger for large molecules.

The restriction that electrical influences must be absent is not a serious one, for we are able to control the external electrical field and to eliminate it when we wish. The gravitational field must be taken into account for precision work. This effect is also proportional to the volume of the solute molecule and to the difference between its density and that of the medium. For a protein in water, with densities 1.33 and 1.00, the relative change in concentration per centimeter is 10^{-8} times the molecular weight. For most soluble proteins the effect is small. For viruses it is very large. The extension of this treatment to centrifugal fields, which behave like very large gravitational fields, is one of the most powerful methods for the study of large molecules.

The difficulties with large molecules increase for heterogeneous equilibrium. Since the interfacial area can be decreased by the formation of a large particle from several small ones, the solubility of a dispersed phase depends upon the size of the particles. If the shape of the particles remains constant, the effect on the chemical potential of the solute is proportional to the molal volume of the solute, and to the interfacial tension, and inversely proportional to a linear dimension of the particle. The vapor pressure of water is ten times as great from a drop 10^{-7} cm in diameter as from a plane surface. The effect of particle size on the solubility of salts indicates that the interfacial tension is ten to fifty times as great as the surface tension of water. Protein molecules are so large that the interfacial tension of a protein-solution surface must be very small indeed if the effect of particle size does not persist to particles of the size usually used for solubility measurements. The concentration at an interface of a substance which reduces the interfacial tension is proportional to the change in surface tension per mole of solute, and thus proportional to the number of surface active groups per molecule which can reach the surface. Surface denaturation is apparently due to the disruptive flattening of a globular molecule so that more groups can reach the interface. The importance of absorption at interfaces in biological systems must be extremely great.

If one of the phases is solid, the effect of strain, which causes the pressure to be different in different directions, is usually greater for large molecules than for small because the strain per molecule is greater and also because there is a smaller probability that the larger molecules can adjust themselves to relieve the strain.

Perhaps the most important difference between real systems and the idealized ones of Gibbs is that real systems are seldom truly at equilibrium. This is obviously true of biological systems, but it is also true of most of the inanimate systems we study. Although we talk often of the absoluteness of thermodynamic equilibrium, we usually assume in practice that the equations for equilibrium hold if the system is at equilibrium with respect to the change we are studying and there is no closely related change progressing rapidly. The only excuse I can find for this assumption is that it appears to work. I quote Gibbs again, this time from his letter to Bancroft:

> The meagreness of the results obtained in my E. H. S. [Equilibrium of Heterogeneous Substances] in the matter of electrolysis has a deeper reason than the difficulty of the evaluation of potentials.
>
> In the first place, cases of true equilibrium (even for open circuit) are quite exceptional. Thus the single case of unequal concentration of the electrolyte can not be one of equilibrium since the process of diffusion can not be stopped. Cases in which equilibrium does not subsist were formally excluded by my subject, and indeed could not be satisfactorily treated without the introduction of new ideas quite foreign to those necessary for the treatment of equilibrium.
>
> Again, the consideration of the electrical potential in the electrolyte, and especially the consideration of the

difference of potential in electrolyte and electrode, involves the consideration of quantities of which we have no apparent means of physical measurement, while the difference of potential in "pieces of metal of the same kind attached to the electrodes" is exactly one of the things which we can and do measure.

The case of unequal concentration of the electrolyte, or a concentration cell with transference, is a cell in which two identical electrodes are immersed in solutions of the same electrolyte at different concentrations, the solutions meeting at a liquid junction. The passage of current effects exactly the same change of state as diffusion, or its reverse. Yet electromotive force measurements may be made very accurately, and the chemical potentials determined from them agree excellently with those by other methods. A slight effect of a very sharp concentration gradient was first noted by Buehrer and me with hydrochloric acid cells. We attributed the effect to a change in temperature due to the heat of dilution by diffusion. Our explanation was confirmed by Hamer's work with sulfuric acid, for which concentrations may be chosen to make the heat effect either very large or zero, and the magnitude of the electrical effect depends entirely on the magnitude of the heat effect. The fact that an irreversible process giving the same change of state as the reversible process affects the measurement of the chemical potential only as it affects the temperature is the best justification I know for our use of equilibrium thermodynamics in systems which are not in equilibrium with respect to all processes.

An extreme example is the quasi-thermodynamic treatment of the rates of chemical reactions, based on Brönsted's theory of the critical complex. It assumes that the rate of a reaction is proportional to the concentration of an intermediate critical complex which decomposes so rapidly that it almost always forms the products if it is made from the reactants and almost always forms the reactants if it is made from the products. It is so unstable that its concentration can not be measured, but the effect of changes in the medium on the reaction rate can be determined by calculating from the theories of statistical mechanics its activity coefficient and those of the reactants. The success of this treatment is very nearly the same as that of the application of the same theories of statistical mechanics to chemical or physical equilibrium in stable systems.

The properties of a system which is not at equilibrium depend upon more variables than those of a system at equilibrium, for they must depend also upon the extent of every change of state which is not at equilibrium. These changes include: chemical reactions, which may be either homogeneous or heterogeneous; changes of concentration within a phase, between two phases or at an interface; changes of particle size in a dispersed phase, which may be solid, liquid or gas; changes of orientation relative to an external field, relative to an interface, or relative to other molecules in a solid or in a liquid crystal; and changes of crystal systems, changes of shape or changes of strain in a solid phase. If the extent of the change can be measured it is possible to treat the system as though it were at equilibrium at any stage of the change. Otherwise we assume that the system has had time to reach equilibrium. The time necessary to reach substantially the equilibrium state will vary enormously for different changes and different systems. It is much larger for many biological systems than for most of the systems studied by physical chemists. Each extension should be tested to ensure that the times are sufficient.

If my talk should persuade you to read Gibbs, you will note that many of his expressions contain an inequality as well as the equality I have discussed. This inequality covers the case in which a component is entirely absent from a phase which is in equilibrium with another phase which contains that component. Then we can only say that the chemical potential of the substance in the phase in which it is absent is equal to or greater than its potential in the rest of the system. For substances whose behavior approaches the perfect gas law or Henry's law at zero concentration, the chemical potential is minus infinity at zero concentration, and is therefore certainly less than its potential in any phase where the concentration is finite. Either it is impossible to have a component entirely absent from a phase in equilibrium with a phase in which it is present or its potential must behave very differently in such a phase and in one in which the substance can be present. Though most of us find the first assumption more reasonable, there seems no possibility of a direct answer to this problem. We may, however, define a component as practically absent from a phase if its concentration is so small that we can not measure it or its effect on the chemical potential of any other component by the methods we are using to study the system. By this criterion we often find a component practically absent from a phase in equilibrium with another phase in which it is present.

Too great insistence on thermodynamic rigor is not always helpful. I think it has hurt one important aspect of applied physical chemistry—the measurement of hydrogen-ion activity or pH. Most physical chemists have never liked the saturated potassium chloride bridge system for two reasons. They believe it is not accurate experimentally and not rigorous theoretically. It is certainly easy to make inexact measurements of pH by this method, and there must

be thousands such made every day. I believe, however, that the experimental uncertainty due to the liquid junction potential can usually be reduced below the uncertainty due to the electrode just as in a simple concentration cell. The important factor is probably the heat effect at the liquid boundary, which I discussed above. The broad junction developed by Clark diminishes the disturbance, but not always enough to make up for the increase in the difference between the two solutions. Thermostating of the junction with liquid to give a large thermal capacity should greatly decrease the experimental difficulty. I think that the same amount of care would give as great precision with the salt bridge cell as with the cell with a silver chloride electrode and added chloride for the determination of acid and base dissociation constants by extrapolation to zero concentration. Effects which start out proportional to the square root of the ionic strength are only half as large for the salt bridge cell.

The theoretical difficulty lies in the fact that we can not measure the chemical potential or the activity of a single ion species. This is closely related to the fact that there is no rigorous definition of electrical potential difference between two different media as noted in the last paragraph quoted from Gibbs. Such difficulties are not new in thermodynamics. We can not determine the enthalpy or heat content of any substance, but we can measure the difference of enthalpy corresponding to a given change of state. So we have agreed on the arbitrary definition that the enthalpy shall be zero for each element and for the hydrogen ion in water, each in its standard state. The inclusion of the hydrogen ion takes care of the fact that we can not measure the properties of any single ion species. The standard free energies, or chemical potentials, are defined by a similar arbitrary definition. The standard molal electrode potentials require an arbitrary definition only for hydrogen and for the hydrogen ion in water, but not for the other elements.

We need an arbitrary definition of the variation of one single ion activity with changes in the medium. Various definitions have been proposed, but the physical chemists have not been able to come to an agreement in this matter. For simple solutions the best proposed so far is the extension of Brönsted's theory of specific ion interaction which, for electrolytes with univalent ions, states that in a pure salt the activity coefficients of the two ions are equal, and that in salt mixtures of constant total concentration the logarithm of the activity coefficient of any ion is a linear function of the concentrations of ions of the opposite sign, but is independent of the concentrations of ions of the same sign. The theory for more complex electrolytes is just as definite but not so simple to state. This definition gives a means of calculating single ion activities in simple solutions of known composition, but it does not give any means of measuring single ion activities.

A definition which is much more generally useful is that at constant temperature the electromotive force of a cell made up of a hydrogen electrode in the solution under consideration, a saturated potassium chloride bridge, and a constant electrode measures the chemical potential of the hydrogen ion in the solution under consideration. Then the replacement of the hydrogen electrode by any other electrode will give a measure of the chemical potentials of the substances reacting at that electrode. Such a definition does not contradict any measurements or theories which do not involve single ion activities. If the molal electrode potential for the cell with hydrogen electrode is so chosen that the activity of the hydrogen ion approaches its concentration in one extremely dilute solution, the same relation will hold in all dilute solutions for the hydrogen ion and also for any other ion. This definition gives no deviations from the logarithmic term proportional to the square root of the concentration. We should be able to calculate the change in potential of this cell with changing salt concentration to terms proportional to the salt concentration. Some of my early work indicates that at moderate concentrations there is a contradiction between this definition and that of Brönsted for hydrochloric acid solutions, but the contradiction is probably not serious. There is much experimental work which indicates that the definition is not a useful one for solutions very concentrated in a non-electrolyte, in which the solvent may be regarded as changed. Such solutions also offer experimental difficulties which make the application more difficult as well as less useful.

I do not believe that anything I can say about hydrogen ion activity measurements will either increase or decrease the use of such measurements or change the technique of routine work. I do hope that what I have said will reduce the sense of inferiority, which has become almost a complex, and will thus increase the precision of this type of measurement when the system and the problem justify such precision.

The definition of the hydrogen ion activity also makes the cell with inert electrode and salt bridge give a direct measure of the oxidation-reduction potential, which may be considered a measure of the chemical potential of the electron. The complications which arise when oxidation-reduction reactions will not proceed rapidly at the electrode except with catalysts have played such an important part in the study of these potentials that they need no emphasis here.

These two equilibria involve two substances, pro-

tons and electrons, which exist in ordinary solutions only at extremely minute concentrations, but which still attain equilibrium with the rest of the system rapidly. Another very important equilibrium involves water, the most abundant component of biological systems, which appears able to go from one part of the body to another so rapidly that minute changes in its chemical potential are important. The activity of water in our blood is only about half a per cent. less than in pure water and only about two thousandths of a per cent. less than in its ultrafiltrate. Yet the balance in a biological system appears to depend upon a small fraction of the latter difference, which corresponds to the effect of a pressure of twenty-five millimeters of mercury. Even the simplest system of interest to the biological chemist is a very complicated one for accurate thinking. To improve over the ideal solution treatment developed by van't Hoff and Donnan, it is necessary to keep very clear the distinction between activity coefficients and osmotic coefficient and not to forget which variables are being maintained constant. This is also one of the cases in which second approximations partially cancel each other so that the first approximation is much better than a treatment which uses the second approximation in one part but the first in another.

The distributions of many other substances throughout the body make some of the most interesting and probably the most important problems of biological chemistry. Not all can have the same chemical potential throughout, but the first step in the study must be the determination of how far the actual distribution varies from the equilibrium distribution because of impermeability, slow permeability or other cause. The rest of the problem will require knowledge outside of thermodynamics, although there will be no violation of thermodynamic laws. For two examples, it would be very valuable to know how closely two changes of state must be coupled so that a decrease in free energy in one may compensate for an increase in free energy in the other, and also what concentration gradients are produced by a temperature gradient which is maintained constant in spite of flow of heat.

The details of a review of this kind are essentially personal and subjective. The examples are mostly taken from protein chemistry, partly because I believe it important, but largely because I am less ignorant of protein chemistry than of the other branches of biological chemistry. I have called attention to those applications of thermodynamics which I believe need more careful scrutiny and to another application of which my opinion is much higher than those of most physical chemists. Yet it would be unfortunate if this question should become one of my authority against that of my colleagues. The most important part of my contribution is impersonal and objective. It is the reminder that each new application can and must be thoroughly tested without regard to the name associated with it.

THE TRAINING OF BIOLOGISTS[1]

By Professor PAUL WEISS

THE UNIVERSITY OF CHICAGO

A FEW comments to introduce our topic may seem appropriate. Why this conference on the Training of Biologists? Well, simply because by shaping future biologists, we shape the future of biology. And there seem to be some grounds for concern. The question is: Can we profitably consider the many ramifications of a *training program* in biology without having a unified concept of *Biology* itself? There is our cardinal issue: What *is* biology, and what would we want it to be like? If we accord to biology the dignity of an integrated, consistent and coherent science, rather than view it merely—if you pardon the irreverent figure of speech—as a holding company embracing numerous separate and independent enterprises, then a clear understanding about the substance, aims and limits of this science would help to establish a sort of central beacon with regard to which we could orient ourselves, when dealing with subordinate issues. Then, anybody's problem becomes everybody's concern, and the common ground for this meeting of representatives of diverse interests is satisfactorily circumscribed.

Our meeting seems timely, or even overdue, in view of world events. In this world crisis, science finds itself confronted with mounting short-range demands and an altered long-range outlook. All around we hear it being predicted, that after this crisis has come to pass—in fact, if it is to be overcome for good—this world can never be the same again; and that, if the change is to be for the better, the critical, disciplined, fact- and relation-conscious mind of the scientist will have to be accorded a major share in the improvement.

[1] Address by the Chairman of the Conference on the Training of Biologists, held in connection with the Fiftieth Anniversary Celebration of The University of Chicago on September 18–20. A full report of the proceedings of the conference will be published at a later date. Aid by the Carnegie Corporation of New York is gratefully acknowledged.

If experience and reason are to gain the ascendancy over emotion and superstition in the conduct of human affairs, man will have to know more about man, and then live up to his knowledge. Since for much of this knowledge he will have to call on biology, it becomes our responsibility to provide a generation of biologists fit to answer the call.

Only partly will their fitness depend on biological competence. Unless they are also made conscious of their obligation to society, they will, I am afraid, be at a loss to justify their subsidized existence to a society asking uncomfortable questions. As the support of science will become incumbent on increasingly broader strata of society, for reasons of which you are aware, more and more such questions will be asked. And the biologist will have to be convincing in showing cause why what he is doing should not be discontinued as a publicly supported enterprise. The research man must prove that his work is more than a glorified hobby, the teacher that he is more than a slow-motion rendition of a text; the practicing biologist being the only one who will be taken for granted because of the plausibility of his utilitarian value.

Now, it is somewhat alarming to have to think of the possibility that in some future attempts might be made to set up an authoritarian agency to sit in judgment, and exert control, over what a scientist should or should not do or teach. Science would choke in such an atmosphere. But it is just as alarming to think of what would happen if the coming generation were left with the illusion that society will continue to stand for the random movements of unoriented and confused minds, privileged to receive public support for their playful exertions, good or no good, just because the story goes that a blind hen, too, occasionally finds a grain. Presumably, an economically minded society would withdraw its support from what it considers a bad investment, and science would be starved. It is up to us to avert both these dangers of either thus choking or starving our science.

We can do this, I submit, by waking up our students to the realization that their privilege of carrying on science as a public trust carries responsibilities. Heighten their sense of responsibility, and they will all by themselves check and recheck their conduct and activities by the standards of scientific and social ethics of which they will have been made conscious; and they will give a good account of themselves under any enlightened scrutiny. But keep on leaving them in the dark, and the whole structure of science will suffer.

This is not advocating indoctrination, but merely a better and more explicit exposition before the student of the philosophic, historical, methodological and cultural foundations of his science, than he is commonly offered. He ought to learn not only how to do things, but also how to rate the results of his doings, so that he may intelligently chart his course, ever on guard against the blind alleys of wasteful monomaniac pursuits. He should learn what his science is all about, how it has grown and how it might be made to grow even better, and what he might contribute to that end. He must learn to plan his activities in teaching and research so that they will furnish useful contributions to the organic growth of integrated knowledge, rather than mere punchcards in an enormous filing system.

So long as science was a pioneering adventure of only a few treks into vast terra incognita, there could be unlimited freedom of movement. With science becoming more and more a proposition of mass team work, some sort of traffic control becomes necessary, and we would rather see this come about through the self-control of drivers properly instructed in their responsibilities than by the equivalent of police enforcement. If we unfold before the students the whole plan of that campaign for the conquest of nature that is science, rather than simply teach them how to handle the weapons in that campaign, we shall enable the better ones to pick all by themselves strategic positions of greatest promise of advancement to science, and the less gifted ones, at least, to do with greater understanding what they are called upon to do.

Now, here I feel lies our first duty. If we are to give the student insight into the plan of this campaign that is science, we must first know the plan ourselves. But do we have one? Are we agreed on how best to serve the progress of biology, is there unity behind our purpose and consensus on procedure? To answer these questions is well within the province of this meeting. Unless we succeed in answering them to our mutual satisfaction, we shall have to keep temporizing with the various partial issues of our educational program, which it would be so infinitely easier to deal with as part and parcel of a single broad fundamental policy. It will have to be our task, therefore, to see whether we can agree on certain common programmatic principles.

Let us take an example: the rating, in both teaching and research, of *facts,* as against *principles.* Or, as I would prefer to state the issue: information *vs.* knowledge. This issue has been amply argued with much verbiage, some wisdom and little consequence. Some of us undoubtedly have strong convictions in the matter, and we shall differ in our views. We may or may not be able to reconcile them. But at any rate, the eventual turn of the argument will necessarily influence all such matters of policy as, for instance, whether students should be made to dissect more specimens or more concepts.

The way I see it, the relation between factual data

and knowledge is the same as that between food and a growing organism. Like food, so-called pure facts must be digested, resorbed and assimilated in order to become knowledge; and unless they are, they become wastes. Already the hoard of unconsumed facts has become so enormous that to point—by way of alibi—to their possible utility in some future, sounds no longer convincing; if ever their time should come, they will long have become obsolete, if not altogether forgotten. This applies to unrelated facts of research as well as to unrelated data in teaching.

Now, the question is obviously not whether we should teach facts and techniques *or* principles and concepts, but rather what proportion of the student's time and energies we should allocate to the ingestion of facts on the one hand, and their digestion on the other, given a certain educational aim and a definite time limit for its attainment. It seems that, instead of letting these proportions be decided by individual preferences, institutional traditions, technical expediency and sheer accident, we might find some more pertinent formula of apportionment.

It will be the same with most of our other problems: Proportions and not volume will be the main issue. It would be idle to indulge in dreams of what volume of knowledge we, preoccupied as we are with our individual fields of specialization, would like to communicate to our students, if we had not to compete for their time, interest, endurance and resorptive capacity. The volume of instruction will always be limited by the hard reality of restricted facilities and human nature. But even though its volume may have to vary widely, the proportions of any program may be preserved without distortion. It is on these proportions, on the harmony of the educational program that we should insist. This implies that in apportioning subject matters, attention will have to be paid not only to their factual content, but likewise to their potential value in developing those faculties which transform a student of biology into a biologist. Any carefully conceived program will have to strike a sound balance between attention to detail and generalization; between observation and experiment; analytical acumen and broad perspective; intellectual mastery and manual craftsmanship; mental stability and critical acumen; respect for tradition and courage to break it when necessary for progress; and so on. It should be easier to find our way through this maze of concrete problems with a central objective in view as our directive, than if we continued to drift apart along our various lines of specialization. Gathered here, therefore, as we are from those various lines, we may attempt to reweave a solid fabric of general biology out of the dangerously separating threads of departmentalization.

If, after these five sessions, we shall part with some clarification of purpose as guide for future action, this is all the reward we may duly expect to come from this venture. If, in addition, our collective opinion should turn out to point a way as to how to translate our conclusions into concrete action, so much the better.

ANNIVERSARY ADDRESS OF THE PRESIDENT OF THE ROYAL SOCIETY[1]

By Sir HENRY DALE

DIRECTOR OF THE NATIONAL INSTITUTE FOR MEDICAL RESEARCH

As we come to the end of another year we can see, as yet, no prospect for science of escape from urgent preoccupation with the means of waging war. On the contrary, with the Union of Soviet Russia now locked in a supreme struggle for its own existence and the world's freedom, and with the United States of America rapidly directing its tremendous scientific and technical potential to the support of the same great cause, the diversion of science from its normal uses and objectives has spread right round the world. Yet even this grim necessity has brought with it some measure of compensation, in drawing closer the bonds of friendship, between the men of science in the countries thus united in a common purpose. We in Britain received a tremendous encouragement in the early months of this year, from the visit of President Conant and his associates to establish here, in London, an office for the maintenance of regular and intimate cooperation, between the war researches of our American colleagues and those which are here in hand. More recently, and in spite of all difficulties of communication, the sense of a common peril and a common determination is bringing us into a new and growing intimacy of collaboration with our colleagues of Soviet Russia. The organization of the science of the British Empire for war has brought to London already a number of distinguished colleagues from the Overseas Dominions, and we have heard of others who are on the way. It has been a particular pleasure to gather them here, in the house of the Royal Society, and to invite them

[1] Concluding part of the address given at Burlington House, London, on November 11, 1941.

to regard it as a center and a rallying point for discussion of the means by which this new and closer collaboration, arising under the stimulus and the necessity of war, may be perpetuated and strengthened for the purposes of peace.

Generous gifts to the society, during the year, from sister societies in America, have given further welcome evidence of the determination of our colleagues there to come to the help of British science in this time of need. The American Philosophical Society, founded in 1743 by Benjamin Franklin, with this society as his model, sent us ten thousand dollars "for the aid of science in Britain." They have confirmed our interpretation of their fraternal gift, as betokening a desire to help us to preserve some measure of normal scientific activity in this country during the war, and to keep alive the tradition of a free pursuit of knowledge for the benefit of all men. We have been able to find good use already for a large part of this benefaction, in the maintenance of a number of important researches, which war conditions had threatened to interrupt or to bring to an end. The American Physiological Society similarly sent us five thousand dollars, as a spontaneous contribution, to the support of scientific publication in Britain, mentioning physiology as the subject to which they, as physiologists, desired us to give the first consideration. The Rockefeller Foundation, that truly international benefactor and promoter of natural knowledge, had already asked us to be responsible for the distribution of twelve thousand five hundred dollars in aid of scientific publication in Britain in these difficult times.

As I have taken occasion earlier to state, gifts such as these, welcome for their own intrinsic value and for the practical uses which we are readily finding for them, are even more welcome on account of the evidence that they bring, of the feeling of comradeship between our American colleagues and ourselves. We can do no less, I think, than assure them of our determination that this closer sense of unity in aims and ideals, with them as with our fellow citizens of the British Overseas Dominions, shall not be lost, but rather strengthened, when we face together the new problems which the end of the war will bring.

Though the first and imperative call on the science of all free countries is for the means of winning the war, to save the freedom without which science can not in any true sense survive, we can not put aside the duty of preparing for the part which science must play, in rebuilding and maintaining civilization when peace returns. The conference recently organized by the British Association, on "Science and the World Order," attracted more attention from the press and the public than is usually given to scientific events and discussions; and it was, indeed, an impressive and significant fact that men of science from a dozen or more different countries, some far distant, should have found it possible now to meet, here in our war-scarred London, and to find the time and the impulse for such debate. We may offer our very sincere congratulations on the success of such an enterprise. Many who took part in these meetings, held at a time when science finds itself conscript and organized as never before, for the destructive purposes of war, were clearly ready to support the view that it should be as fully organized by the governments of a world at peace, for its proper purposes of enriching life and enlarging the opportunities of happiness for all men alike. There were not wanting voices, however, such as that of our biological secretary, to sound a warning of dangers which might be entailed, by such fulness of association between science and government as others were advocating with conviction and enthusiasm. Freedom and opportunity, it was pointed out, rather than organization, provide the conditions for the highest types of research, and thus, in the end, for the greatest services which science can give to mankind. I find myself in sympathy with this view, and nobody here, I think, would suggest that it is usually possible to organize the researches which advance boldly into the unknown, and open new vistas to human understanding. Here we shall certainly not overlook the fact that, in the period between the two wars, important funds have been placed at the disposal of the Royal Society by a series of generous benefactors, to be administered for the support of researches over a wide range of subjects, in complete independence of any control by the state.

On the other hand, I think that it will be agreed that the remarkable development in this country, since 1914, of the state support of research administered by the three advisory councils, normally in relation to the needs and the activities of a nation at peace, has taken place without any obvious detriment or danger to the freedom of science. The Royal Society's former function, of advising the government directly on all scientific matters, and of organizing such systematic researches as were then undertaken in the public interest, has, of necessity, been shared and greatly diminished. We as a society, however, can fairly regard this development as, in many respects, a realization of the plans and the dreams of our predecessors here; and I do not think it fanciful to claim that our society's traditions and standards have been still effective, through the influence of our fellows on the advisory councils and their committees, and through the filling of their chief executive offices by men of our fellowship. As a whole-time research worker myself, since 1914, under the body which became the Medical Research Council, and the senior now in that service,

I can bear grateful witness to the freedom of opportunity which can exist under an enlightened organization and control, exercised on behalf of the government. I have no reason to suppose that the conditions are otherwise under the other research councils. Nor should we lose sight of the fact that a further large proportion of the free scientific research of the country is now indebted to support from the state through grants to the universities, administered without any trace of detailed government control.

While, therefore, the existing mechanisms for the support of science by the state are doubtless susceptible of improvement at one point or another, I find no reason to fear any threat to the freedom of science from them, or from any natural development on those lines. Nor do I fear it from a wider use of the organized application of science and scientific method to problems of public welfare; nor, again, from a more effective access of scientific knowledge to those responsible for government. A year ago Sir William Bragg told the society of the formation of the Scientific Advisory Committee to the War Cabinet, under the chairmanship of Lord Hankey, with the president and two secretaries of this society as members *ex officio*. The representation of the society has, indeed, been strengthened since then, and in a manner most welcome, by the fact that, though I have succeeded him *ex officio*, Sir William Bragg still gives his wisdom and experience to the work of that committee, as an extra member.

There is one direction, however, in which I do find some reason to fear for the freedom of science. If science should become entangled in controversial politics, through the over-eagerness of its advocates and champions to invoke the sanction of science, or to claim its potentialities, in support of any special political doctrine, then indeed I believe that the threat to its freedom might become a real danger. Let there be no misunderstanding of my meaning. I am not abusing the privilege of this chair by using "controversial" as an epithet, to be applied to political opinions which I do not happen to share. I see danger if the name of science, or the very cause of its freedom, should become involved as a battle cry in a campaign on behalf of any political system, whether its opponents would describe it as revolutionary or reactionary. If science were allowed thus to be used as a weapon of political pressure, it would be impossible to protect science itself eventually from the pressure of sectional politics. If that should happen the dangers are, I believe, beyond dispute—the danger, for example, that fundamental researches, having no immediately practical appeal, would be allowed to fall into arrears through relative neglect; or the danger that the rigid standards of true science would be relaxed, by allowing the convenience of results for policy or for propaganda to enter into the assessment of their validity as evidence. This society, with its firm and unbroken tradition of complete aloofness from political controversy, may still find it an important part of its function, to keep watch and, if necessary, to stand without compromise, for the right and the duty of science to seek the truth for its own sake, in complete freedom from any kind of extraneous influence. I hope, indeed, that there will never be need thus to invoke our tradition, to protect the freedom and the integrity of science from the enthusiasm and the advocacy of any of its friends.

OBITUARY

FREDERICK HUTTON GETMAN

DR. FREDERICK HUTTON GETMAN, physical chemist, died suddenly on December 2, 1941, at the Stamford Hospital in Stamford, Conn. He had been in failing health for several months but in September attended the meeting of the American Chemical Society in Atlantic City, where he presented a paper.

He was born in Oswego, N. Y., on February 9, 1877. He was the son of Charles Henry and Alice (Peake) Getman. The family had a very considerable fortune, made in the lumber business, and young Getman had an assured position in business if he chose to follow his father's calling. However, his natural inclinations were along other lines. He early developed a taste for music, which remained with him throughout life. He was an excellent organist. Just when he decided to make science his major interest in life is not known to the writer, whether it was under Mallet or Remsen; but we have his own testimony of his love and admiration for the latter. He was educated at Rensselaer Polytechnic Institute, Lehigh University and the Department of Chemistry at the University of Virginia, from which he graduated in 1896. He was an instructor in chemistry and physics in the Stamford High School from 1897–1901. He then went to the Johns Hopkins University, where he received his doctorate in physical chemistry in 1903. He was fellow in physical chemistry at the Johns Hopkins University from 1901 to 1903 but remained as fellow by courtesy during the following year. He then became Carnegie research assistant for the year 1903–1904. Dr. Getman's first position after leaving the Johns Hopkins was as lecturer in physical chemistry at the College of the City of New York. He was then lecturer at Columbia University in physics from 1907 to 1908. In 1909 he became associate pro-

fessor in chemistry at Bryn Mawr College, where he remained for six years.

The need for his counsel at Stamford in his father's business became so pressing that he then decided to change his base to Stamford, although continuing his scientific interests. He took an increasing responsibility in the Getman and Judd Company, of which he became vice-president, but at the same time he built and equipped the Hillside Laboratory, of which he was the director.

Dr. Getman's researches were begun with Dr. Harry C. Jones on the subject of "Hydration in Solution." They achieved notable results from their study of the freezing points of solutions. At Bryn Mawr Dr. Getman continued his work on solutions, making a study of the viscosity of various solutions. At Stamford he installed refractometric and spectroscopic equipment for the study of solutions. Later work was devoted to electrode potentials and chemical activity. The titles of his various papers taken from *Chemical Abstracts* are much too numerous to give in detail.

Dr. Getman was author of several books, of which two will be referred to here. His "Outlines of Physical Chemistry," of late years in cooperation with Dr. Daniels, has gone through many editions and has been a standard text-book in American colleges for nearly a generation, excelling in clarity, conciseness and scholarship. His "Life of Remsen" was published by the *Journal of Chemical Education* as a pioneering effort in the publication of the lives of American chemists. Dr. Getman was engaged at the time of his death in securing the material for the publication of the lives of other American chemists. It is hoped that this work may be continued in other hands.

The broad interests of Dr. Getman are indicated by the fact that he was director of the Stamford Hospital, the Stamford Trust Company, the Ferguson Library and president of the Stamford Symphony Society. On trips in the West he transcribed some of the songs of the American Indians which he worked over into themes suitable for performance by orchestras. He was also active in the Presbyterian Church of Stamford. On November 26, 1906, he married Miss Ellen M. Holbrook, of Plymouth, Mass., who survives him.

EUGENE C. BINGHAM

LAFAYETTE COLLEGE

RECENT DEATHS

DR. ALEXANDER LOWY, professor of organic chemistry at the University of Pittsburgh, died on December 25 at the age of fifty-two years.

DR. LEON PRATT ALFORD, professor of administrative engineering at New York University, chairman of the department of industrial engineering, died on January 2 at the age of sixty-five years.

JOHN W. KIDD, dean of the School of Engineering of the Texas College of Mines at El Paso, died on December 29. He was sixty years old.

J. H. RILEY, associate curator in the Division of Birds of the U. S. National Museum, died on December 17. Mr. Riley had been associated with the division since 1896.

SCIENTIFIC EVENTS

DEVELOPMENTS IN AGRICULTURAL RESEARCH IN GREAT BRITAIN[1]

THE extended field of activity and additional financial resources which have recently been granted by the government to the Agricultural Research Council have opened the door to new developments in this branch of applied science. A large part of the council's activities will still be devoted to coordinating, and advising on, the work of the various research institutes to which the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland are making maintenance grants, and to furthering the interests of these institutes in every possible way; but it is the council's intention to devote some part of the funds to be expended at its own discretion, for which it is answerable to the Lord President of the Council, to the furtherance of agricultural research in university departments and to the enlargement of its own scientific staff. It is, in particular, the council's desire to encourage both senior and junior research workers in the biological sciences to enter the agricultural field. In pursuance of this policy, the council has established two new research units under its direct control, a Unit of Animal Physiology and a Unit of Soil Enzyme Chemistry.

The Unit of Animal Physiology will be under the direction of Sir Joseph Barcroft, with the assistance of Mr. A. T. Phillipson and Dr. R. A. McAnally. This unit will, by agreement with Professor E. D. Adrian, be housed in the Department of Physiology at Cambridge, and will work in close liaison with the Institute of Animal Pathology and the Institute of Animal Nutrition. In the first instance, the staff of this unit will devote a large part of their time to the study of ruminant digestion. The Unit of Soil Enzyme Chemistry will be under the direction of Dr. J. H. Quastel, assisted by Dr. P. J. G. Mann and D. M. Webley. By agreement with Sir John Russell,

[1] *Nature.*

this unit will be housed in the Rothamsted Experimental Station. Dr. Quastel and his staff will, in the first instance, be engaged mainly in the study of the influence on soil fertility of enzyme systems derived from soil bacteria, or from other microorganisms.

COMMITTEE ON ECONOMIC TRENDS OF THE INDUSTRIAL RESEARCH INSTITUTE

IN a survey of "Science in Industry" in 1941, Dr. Maurice Holland announces that recently the Industrial Research Institute (affiliated with the National Research Council) representing more than forty companies in varied fields of industry, known as leaders in technology in their fields, have appointed a committee on "Economic, Political, and Social Trends Affecting Research Policies" to study the deep and significant national trends in these three categories as they are now affecting and may affect in the future research personnel, organization and appropriations.

The primary purpose of the committee is to devise ways and means to preserve research organizations intact after the war. It is looking toward the formulation of a plan which can be sponsored and backed by the only organized industrial company membership group in the United States for some form or method of accumulating a surplus or sinking fund for research in lean times, or some form of economic security such as irrevocable trust funds for research workers, or some form of group insurance especially designed to fit the needs of creative workers in industry.

The report points out that "with the appointment of Dr. Vannevar Bush as director of the Office of Scientific Research and Development, the entire science resources of the nation, including those of the armed services, are now under the direction of one man. For the first time in the nation's scientific history the resources of government, industry and university are integrated and coordinated for the primary purpose of national defense.

"Substitution of industrial materials come second on the list as a significant trend in the defense-dominated scene—with companies crossing industry boundaries. The search for substitute material in the case of at least one large automobile manufacturer has definitely indicated that the substitute material is functionally better adapted to the purpose, is cheaper and more decorative, with the result that they will probably not go back to the original material.

"The publication of 'Industrial Research. II. A National Resource' by the National Resources Board —a survey made by the National Research Council for that body—has had a marked effect in high places in industry and industrial-financial groups in stimulating interest in technical research as one form of 'industrial insurance.' This is particularly true in the management and executive strata of industry and financial organizations."

THE COOPERATIVE COMMITTEE ON SCIENCE TEACHING

UNDER the sponsorship of five scientific societies representing biology, chemistry, mathematics, physics and research in science teaching a committee has been formed to work on educational problems of vital interest to all science teachers which no single organization can solve working alone. The committee is known as the Cooperative Committee on Science Teaching.

Two meetings have been held, one in April and one in November, 1941. Work is now in progress on four problems:

1. Licensing or certification of secondary-school science teachers. The committee hopes to work out a solution that will be practicable and that will be adopted by certification authorities.

2. The college training of prospective science teachers. It is desirable to prepare teachers for teaching certain combinations of subjects rather than to prepare intensively in one subject.

3. Exploratory studies of the secondary-school science curriculum. The committee hopes to stimulate a number of colleges and universities to organize workshops and conferences for bringing together secondary-school teachers to work on their educational problems.

4. Problems of state or local agencies needing the services of educational consultants on questions pertaining to science teaching. The committee offers its services as a consultant to state or local agencies working on problems pertaining to science teaching.

The committee consists of the following members:

Representing the American Association of Physics Teachers: K. Lark-Horovitz, Purdue University; Glen W. Warner, Wilson Junior College, Chicago.

Representing the American Chemical Society: B. S. Hopkins, University of Illinois; Martin V. McGill, Lorain High School, Lorain, Ohio.

Representing the Mathematical Association of America: A. A. Bennett, Brown University; Raleigh Schorling, University of Michigan.

Representing the National Association for Research in Science Teaching: G. P. Cahoon, the Ohio State University; Robert J. Havighurst, University of Chicago.

Representing the Union of Biological Societies: Oscar Riddle, Carnegie Station for Experimental Evolution.

Robert J. Havighurst is chairman of the committee and Glen W. Warner is secretary.

THE AMERICAN FERN SOCIETY

DR. DOUGLAS HOUGHTON CAMPBELL, of Stanford University, has recently (December, 1941) been elected to honorary membership in the American Fern

Society. Dr. Campbell, who has been a regular member of the society for twenty-five years, becomes the fifth botanist to receive this honor during the fifty years' existence of the society, the others being Dr. Carl Christensen, of Denmark; Professor Frederick Orpen Bower, of England; Professor Willard Nelson Clute, of Butler University, Indiana, and Dr. Campbell E. Waters, of Washington. Professor Campbell began his fern work with a research problem on the common sensitive fern, Onoclea, fifty years ago.

The American Fern Society is about to celebrate fifty years of activity relating to ferns. While its official organization and first publication date from 1893, forty-nine years ago, there had been a preliminary gestational period of a year or two before that, during which its nineteen charter members perfected the plans which led to its birth as the "Linnaean Fern Chapter" of the Agassiz Association, and later to an adolescent change into "The American Fern Society." Drs. Waters and Clute have been members for half a century.

From its start with nineteen charter members, the Fern Society has grown to a present membership of over four hundred, comprising fern students from many different professions and walks of life. During 1941, the society's publication, the *American Fern Journal,* completed its thirty-first volume with Dr. W. R. Maxon, of the Smithsonian Institution, as its editor-in-chief. Preceding him, C. A. Weatherby, of the Gray Herbarium, served as editor for a period of twenty-six years. Publication headquarters of the journal are at the Brooklyn Botanic Garden, which also houses its herbarium and library. Before the *Journal* was started (1910), the society sponsored the *Fern Bulletin,* which was edited through twenty volumes by Willard N. Clute.

THE AMERICAN PHILOSOPHICAL SOCIETY

SINCE 1937 the American Philosophical Society has been holding a general meeting in the month of February, at which meetings such topics have been considered as the "Administration of Funds in Aid of Research," the "Publication of Research," "The Centenary of the Wilkes Exploring Expedition," "The Life and Work of Alexander Dallas Bache" and the "Centenary of Geomagnetism in America."

It is proposed to devote the midwinter meeting on February 13 and 14 to the "Early History of Science and Learning in America" with especial reference to the part played by the American Philosophical Society, which this year completes its bicentenary. At present the program includes the subjects and speakers given below:

Mathematics, Frederick E. Brasch, Library of Congress.
Astronomy, S. A. Mitchell, University of Virginia.
Physics, W. F. Magie, Princeton University.
Chemistry (Joseph Priestley), Detlev W. Bronk, University of Pennsylvania.
Engineering, Dugald C. Jackson, Massachusetts Institute of Technology.
Meteorology, W. J. Humphreys, U. S. Weather Bureau.
Agriculture, M. L. Wilson, under-secretary, United States Department of Agriculture.
Botany, M. L. Fernald, Harvard University.
Natural History (Benjamin Smith Barton as naturalist), Francis Pennell, Academy of Natural Sciences of Philadelphia.
Entomology, Philip P. Calvert, University of Pennsylvania.
Geology and Geophysics, Bailey Willis, Stanford University.
Paleontology, George G. Simpson, American Museum of Natural History.
Medicine, Francis R. Packard, Philadelphia.
The American Indian, Clark Wissler, American Museum of Natural History.
Education, Merle M. Odgers, Girard College.
Michaux and His French Associates, Gilbert Chinard, Princeton University.

This program should prove of unusual interest not only because of the subjects and speakers announced, but also because the theme of this meeting has been proposed as the field which should be especially cultivated by our library. This meeting should enable us to assess the present value of our library in this field and to learn of the gaps which should be filled if it is to be an important aid in this department of historical research.

As usual the society will provide hotel entertainment for non-resident members and specially invited guests.

EDWIN G. CONKLIN,
Executive Officer

OFFICERS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

A FULL account of the Dallas meeting of the American Association for the Advancement of Science and the scientific societies associated with it, edited by the permanent secretary, will be printed in the issue of SCIENCE for February 6.

Officers for 1942 were elected as follows:

President

Dr. Arthur H. Compton, University of Chicago.

Vice-presidents and Chairmen of the Sections

Mathematics (A): Marshall H. Stone, Harvard University.
Physics (B): A. J. Dempster, University of Chicago.
Chemistry (C): J. H. Hildebrand, University of California, Berkeley.

Astronomy (D): Edwin F. Carpenter, University of Arizona.
Geology and Geography (E): Chester R. Longwell, Yale University.
Zoological Sciences (F): W. C. Allee, University of Chicago.
Botanical Sciences (G): J. T. Buchholz, University of Illinois.
Anthropology (H): Leslie Spier, University of New Mexico.
Psychology (I): H. E. Garrett, Columbia University.
Historical and Philological Sciences (L): Morris R. Cohen, New York, N. Y.
Engineering (M): W. R. Woolrich, University of Texas, Austin, Texas.
Medical Sciences (N): H. S. Gasser, Rockefeller Institute for Medical Research, New York.
Agriculture (O): A. E. Murneek, University of Missouri.
Education (Q): Harold F. Clark, Columbia University.

Members of the Sectional Committees

Mathematics: W. L. Ayres, West Lafayette, Ind.
Chemistry: William C. Rose, University of Illinois.
Astronomy: R. M. Petrie, Dominion Observatory, Victoria, B. C.
Geology and Geography: Marland Billings, Harvard University.
Zoological Sciences: A. C. Kinsey, Indiana University.
Botanical Sciences: H. H. Bartlett, University of Michigan.
Anthropology: Clyde Kluckhorn, Harvard University.
Psychology: William A. Hunt, Newport, R. I.
Historical and Philological Sciences: Alexander Pogo, Harvard Library.
Medical Sciences: Irvine H. Page, Indianapolis City Hospital.
Agriculture: W. H. Pierre, Iowa State College.
Education: M. R. Trabue, Pennsylvania State College.

Executive Committee

Esmond R. Long, Henry Phipps Institute, Philadelphia, Pa.
W. E. Wrather, Dallas, Texas.

Council

Howard A. Meyerhoff, Smith College.
William E. Wickenden, Case School of Applied Science.

Committee on Grants

A. F. Shull, University of Michigan.
A. L. Hughes, Washington University.

SCIENTIFIC NOTES AND NEWS

DR. ARTHUR H. COMPTON, Charles H. Swift distinguished service professor of physics at the University of Chicago, was elected president of the American Association for the Advancement of Science on December 31, at the Dallas meeting. He succeeds Dr. Irving Langmuir, of the General Electric Company.

MOUNTAIN summits in the Sequoia National Park, all more than 13,000 feet high, with the approval of the U. S. Board of Geographical Names, have been given the names of the following distinguished scientific men: Chamberlin, Hale, Newcomb and Pickering.

THE annual $1,000 prize of the American Association for the Advancement of Science for a notable contribution to science presented at its annual winter meeting has been awarded to Professors Frank H. Johnson, of Princeton University, and Dugald E. S. Brown and Douglas A. Marsland, of New York University, for their paper entitled "The Reversible Denaturation of Enzymes as a Determining Factor in the Reaction of Biological Systems to Temperature and Pressure."

DR. ALWIN M. PAPPENHEIMER, of the New York University College of Medicine, was presented on December 30 with the prize of $1,000 and a bronze medal of the Eli Lilly Company at the joint annual banquet in Baltimore of the Society of American Bacteriologists, the American Association of Immunologists and the American Society for Experimental Pathology.

THE Penrose Medal of the Geological Society of America was presented to Professor Norman Levi Bowen, of the University of Chicago, at the annual dinner of the society at the Boston meeting on December 30.

THE presentation of the Perkin Medal "for outstanding work in applied chemistry" to Dr. Martin Hill Ittner, chemist of the Colgate-Palmolive-Peet Company, will be made at a meeting of the Chemists' Club, New York, on January 9.

PROFESSOR DOUGLAS JOHNSON, of Columbia University, was elected president of the Geological Society of America on December 29 at the opening of the annual meeting in Boston. Other officers elected were: *First Vice-president,* Professor E. L. Bruce, of Queen's University, Kingston, Ont.; *Second Vice-president,* Professor Chester R. Longwell, of Yale University; *Third Vice-president,* Dr. Lloyd W. Stephenson, of the U. S. Geological Survey; *Fourth Vice-president,* Dr. Frederick E. Wright, of the Geophysical Laboratories of the Carnegie Institution; *Secretary,* Dr. H. R. Aldrich, of Columbia University. Councilors elected included past president, Professor-emeritus Charles P. Berkey, of Columbia University; Professor William O. Hotchkiss, of Rensselaer Polytechnic Institute; Dr. A. I. Levorsen,

of Tulsa, Okla., and Professor Rollin T. Chamberlin, of the University of Chicago. The newly elected president, the vice-presidents and the secretary are also members of the council.

AT the Baltimore meeting of the American Society of Bacteriologists, officers were elected as follows: Dr. Selman A. Waksman, of Rutgers University, *president;* Dr. Rebecca Lancefield, of the Rockefeller Institute for Medical Research, *vice-president,* and Dr. William B. Sorrels, of the University of Wisconsin, *secretary-treasurer.*

DR. EVARTS A. GRAHAM, professor of surgery at Washington University Medical School, St. Louis, has been elected a member of the Royal Society of Sciences of Uppsala.

DR. OTTO LOEWI, research professor of pharmacology at New York University College of Medicine, has been appointed Walker-Ames professor of pharmacology and physiology for the spring quarter of 1942 at the University of Washington.

DR. MARIO SOTO has been appointed professor of pharmacology at the University of Buenos Aires. He will devote his time to research and will give up his clinical connections.

DR. BRUNO NOWAKOWSKI, professor of hygiene, has become a member of the faculty of the Polish School of Medicine at the University of Edinburgh.

DR. C. E. LUCKE, Stevens professor-emeritus of mechanical engineering at Columbia University, who retired this year as head of the department of mechanical engineering, has been appointed by the Chemical Construction Corporation, New York, consultant in the selection and installation of power-generating and mechanical equipment.

WILLIAM C. WHITE, engineer in charge of the vacuum tube division of the radio and television department of the General Electric Company, has been made director of an electronic laboratory which has been established by the company for the centralization of its activities in this field. He is succeeded in the vacuum tube division by O. W. Pike.

DR. Z. I. KERTESZ, chief in research in chemistry at the New York State Experiment Station at Geneva, has been granted a six months' leave of absence to engage in research on the production of various citrus products on a project sponsored by the Federal Government at Dunedin, Fla.

THE American Chemical Society has announced the formation of a committee on economic status, to conduct a survey of the chemical profession in America in cooperation with the U. S. Bureau of Labor Statistics. Dr. Lawrence W. Bass, assistant director of the Mellon Institute of Industrial Research, Pittsburgh, has been made chairman.

DR. WILLIAM C. STADIE, professor of research medicine at the University of Pennsylvania, will deliver the fourth Harvey Society Lecture of the current series at the New York Academy of Medicine on January 15. He will speak on "Intermediary Metabolism in Diabetes Mellitus."

THE appointment of a special committee entitled "A Committee on Wartime Requirements for Specialized Personnel" has been announced by the National Resources Planning Board. This committee will function as a part of the National Roster of Scientific and Specialized Personnel, of which Dr. Leonard Carmichael is director. The names of the committee, announced by Frederic A. Delano, chairman of the National Resources Planning Board, are: Dr. Leonard Carmichael, *chairman;* Dr. Edward C. Elliott, president, Purdue University; Marion B. Folsom, treasurer, Eastman Kodak Company; Dr. Guy Stanton Ford, ex-president, University of Minnesota; Brigadier General Lewis B. Hershey, director, Selective Service System; Edward F. McGrady, special adviser to the Secretary of War; Monseigneur John A. Ryan, National Catholic Welfare Council; John W. Studebaker, commissioner of education, Federal Security Agency; Dr. Baldwin M. Woods, University of California; Owen D. Young, honorary member of the Board of Directors, General Electric Company. James C. O'Brien, executive officer of the roster, will act in a similar capacity for the work of this committee. The committee is being asked to formulate recommendations and report to the National Resources Planning Board as quickly as possible.

CIVIL SERVICE examinations are announced as follows: For analytical and research chemists, with salaries of $2,600 to $5,600 a year—any specialized branch of chemistry is included; analytical chemists at $2,600 to $3,200 are needed for chemical testing of materials, for compliance with specifications, checking health hazards by chemical methods and other analytical chemistry work—and for pharmacologist and toxicologists, $2,600 to $4,600 a year. In both these examinations, responsible professional experience must be shown, except for the partial substitution of graduate study. The Naval Observatory in Washington, D. C., is in immediate need of junior astronomers. The register of eligibles established as a result of the 1940 examination for junior astronomer is exhausted. These positions carry salaries of $2,000 a year and for sub-professional positions from $1,620 to $1,800. The U. S. Public Health Service needs health education consultants at $3,800 a year; associates at $3,200, and assistants at $2,600.

THE Torrey Botanical Club, New York, will celebrate the seventy-fifth anniversary of its foundation, beginning on June 22, when an anniversary reception and banquet is planned. During the week there will be symposia, addresses and field trips. Visits will be conducted to institutions and to places of botanical interest in and near New York.

THE Agricultural Experiment Station of the School of Agriculture, Stillwater, Okla., celebrated its fiftieth anniversary during the golden jubilee celebration of the Oklahoma Agricultural and Mechanical College on December 13, 14 and 15. Dr. Henry G. Knight, chief of the Bureau of Agricultural Chemistry and Engineering, who was director of the Oklahoma Station from 1918 to 1921, was one of the principal speakers, representing the research activities of the land-grant colleges. He spoke on "Future Markets for Farm Products" and on "Chemists and Engineers in Agriculture." Among the graduates of the institution who were named during the jubilee as the initial members of a newly established "Hall of Fame" were: Dr. R. R. Shively, vice-president and chief technologist of B. F. Drakenfeld and Company, "for his research contributions in the chemistry of ceramics and glass," and Dr. Roy C. Newton, vice-president in charge of research for Swift and Company, "for his combination of scientific and executive skill in building the research department of that company."

As a war-emergency measure, the Harvard Medical School, the Boston University School of Medicine, the Tufts College Medical School and the new Harvard School of Dental Medicine have issued a joint statement to the effect that, beginning on July 1, they will go on a twelve-month basis. The new program of continuous operation will do away with the present summer vacation period and will shorten the period of medical training to three calendar years instead of four. Graduates of the School of Dental Medicine will qualify in four and a half years, instead of five as originally planned. No change in the amount of required work is contemplated in any of the institutions involved, and there is no intention of lowering standards.

THE Yale University School of Medicine will be conducted the year round for the duration of the national emergency. The course will thus be shortened from four to three years, and each year will comprise four terms of eleven weeks. Tuition for the full course will remain unchanged at $2,000. Because of the reduction in time for elective work, the thesis requirement will be waived for classes graduating in 1943 and thereafter under the three-year plan, but the thesis will be continued as an elective. It was also announced that provision had been made to increase the enrolment of each entering class from fifty to sixty students. The summer term will begin on June 29.

THROUGH a bequest of the late William Campbell, for many years Howe professor of metallurgy at Columbia University, two fellowships have been established. They are awarded primarily for graduate study and research in the field of metallurgy. Practical experience in metallurgy or previous graduate study is desirable. The stipend of each fellowship is fixed at the time of award by recommendation of the committee and will normally be an amount sufficient to meet the necessary living expenses of the incumbent of the fellowship. Further information can be obtained from Professor Eric R. Jette, School of Mines, Columbia University.

ACCORDING to the *Journal* of the American Medical Association, Harvard University and the Massachusetts General Hospital, Boston, have reached an agreement whereby the main phases of the work in cancer treatment and research now being carried on by the Collis P. Huntington Memorial Hospital of Harvard Medical School will be transferred to the General Hospital. The step was taken because of the belief that the care and treatment of medical specialties can be more efficiently handled as part of a large institution of general scope than in smaller individual units. Under the new arrangement there will be transferred to the Massachusetts General Hospital the in-patient and out-patient services at the Huntington Memorial. The laboratory and research work now carried on by the Harvard Cancer Commission, established in 1899, will continue under the supervision of the commission. The research activities of Dr. Joseph C. Aub, associate professor of medicine at the Harvard Medical School, will be carried on at the General Hospital in connection with the tumor clinic which the hospital has been conducting for many years. The remainder of the varied research work of the cancer commission will be continued in conjunction with the medical school. The equipment of the General Hospital, including its 1,000,000 volt x-ray machine, will be available to all patients at both the Huntington and the General Hospital, and the Harvard supply of radium, heretofore used at the Huntington, will be available to the Massachusetts General Hospital.

THE first report of the Sub-committee on the Ecology of Marine Organisms, Committee on Geologic Research, has recently been issued by the National Research Council. It is a mimeographed bulletin of fifty-two pages, containing material presented last May at the annual meeting of the Division of Geology

and Geography. Most of the data in the report were obtained by the sub-committee in a canvass of individuals and institutions interested in marine ecology as related to paleontology. The report attempts to present a picture of current and recently completed activities together with an annotated bibliography of a number of recently published papers. The Division of Geology and Geography wishes to give the report a fairly wide distribution in the belief that it will be found useful by paleontologists. Copies have been sent to individuals and to libraries, particularly those in the geological departments of colleges and universities. A limited number of copies are on hand and will be mailed to those desiring them. Requests should be addressed to the Division of Geology and Geography, National Research Council, 2101 Constitution Avenue, Washington, D. C., accompanied by fifteen cents to cover cost of postage and handling.

DISCUSSION

THE CURRENT LIST OF MEDICAL LITERATURE—AN EXPLANATION

LATELY, much has been written of the little planeographed weekly list of medical literature issued by the Friends of the Army Medical Library. One of the latest comments, and a very intelligent one at that from the view-point of its writer, was an article published in the September 26 issue of SCIENCE, in which Joe Hare, of the University of Denver, praised the list as being *"potentially by far the most important index"* of current literature in any scientific field (italics by me). He called the list an *index,* and criticized its "weird" classification. Since he also expressed his fear that the carelessness of classification committed by the weekly list may reflect badly upon "the excellent classification found in the Index-Catalogue," I think that it is time to throw light upon the historical background of this new bibliographical aid, upon its aims and its *accidental* relation to the Army Medical Library and its Index-Catalogue. Being one of the midwives assisting at the birth of the weekly list, and, to a certain extent, nursing it through its infancy, I may probably tell more about the difficulties of its birth, the weak constitution of the child, and so forth, than the casual observer.

The rather short history of the Current List is closely connected with the development of microfilm service of the Army Medical Library. This service can be traced back to 1937. In that year, Colonel Harold W. Jones, the librarian, saw the great possibilities of microfilming, and gave permission to the Bibliofilm Service, then operating at the Department of Agriculture, to film the library's books and journals if requested by the customers of that service. During the following two years, Bibliofilm Service copied many books and journal articles in the Army Medical Library, but it was felt that such an external agency would never be a proper substitute for what should be an extension service of the library. Filling out its many orders was always a great burden to the library staff which, since it did not have any supervisory power over the preparation of microfilms, could do little or nothing for the improvement of films delivered to patrons who always considered the library responsible for any defects found in the films received. For this and many other reasons it seemed to be desirable to establish a microfilm service of our own, operated in the spare time of our employees.

About a year ago, Dr. Seidell, who has been one of the early sponsors of the inauguration of microfilm services in public libraries, offered the librarian a microfilm equipment to be installed in the library building. The library being a government operated institution, a microfilm service could not become an official part of the library without a special authorization by Congress and without appropriation of public funds for its management and maintenance. In addition, an official microfilm service was not at all desirable because its operation would require a large personnel for bookkeeping, accounting, and so on.

A group of persons of high professional standing, who later took the name of Friends of the Army Medical Library, decided at this time that, instead of going through the endless maze of official sanction, the microfilm service should operate as a private organization of the Friends, with permission of the Surgeon General of the Army.

The Friends realized that a microfilm service without a sufficient steady patronage sooner or later would have to be discontinued. Of what avail is a microfilm service for a scientist who is not informed about the recent material available in the library? Should he wait until the printed and classified bibliographies call his attention to the recent developments? Or should the man from Texas or Oregon fly to Washington in order to glance through the subject cards prepared daily by the library staff for the Index-Catalogue from the large daily mail of scientific journals? Here seemed to be an opportunity for the Army Medical Library to become a bibliographical source for the medical research of the whole nation and even of the entire Western Hemisphere. Therefore, the Friends sought for means to extend the library's services and to build a bridge between the card file of the library and the study desk of the scientist.

Theoretically, a daily list of medical literature or a

contact by the Teletype system would best answer the scientist's eagerness for quick information, but none of these is practical or economical. The next best solution seemed to be a weekly list of scientific papers. This idea had its chief support in the fact that there was almost no money needed for the preparation of the list. The proposed Current List did not need money in order to subscribe to thousands of medical journals, nor to maintain a large staff of indexers and foreign translators. Neither did it need any to pay an editorial staff. Almost everything was there, ready in the library, ready for a lease-lend. The Friends merely needed to borrow the daily achievements of the library staff, and to allow the references to medical papers to be copied by a typist.

Thus the weekly list took its origin as a private publication of the Friends. It was called a *list* with purpose, and it should not be taken for anything else but a private list, and a very primitive type of bibliographical aid at that.

The method of arrangement was selected in order to avoid even the slightest pretension to being called a classified index, and to prevent any confusion with the official publication of the library, the Index-Catalogue.

It should not be forgotten that in preparing the weekly list, the Friends are just readers of the library, borrowers of its material. The reference cards of the Index-Catalogue are *loaned* to them at the closing time of the library; they are copied at night, and returned next day to the regular subject file of the library. There is no connection whatever between the publication of the Current List and the Index-Catalogue, beyond the borrowing of the cards. The list is prepared outside the library, the arrangement of titles and the grouping of journals by pasting the typed sheets under the 44 arbitrarily selected groups being done at the private home of the typist. Everything is necessarily done hurriedly in order to have the weekly issue ready in time. There is no supervision of the copy prepared for planeographing. The Friends do not supervise. On the other hand, neither the librarian nor the editor of the Index-Catalogue nor the library itself could or should assume officially any editorial supervisory power over such a type of privately issued list; nor under these circumstances can they be held responsible for the "weird cataloguing" in the list.

In fact, it is doubtful if any one should be blamed when in an unclassified list of scientific papers the contents of a whole number of an entomological journal sometimes crawl into the Anthropology class, or if the Archiv für Rassenbiologie slips into the Microbiology group. It would not be possible to arrange half of the contents of a journal under one heading, and the other half under another heading if, by its title, the journal itself happens to belong to the group of Societies and Miscellaneous. The article on "Vitamin K in obstetrics," mentioned by Joe Hare as an example of slipshod classification, was published in the *Journal of the Medical Society of New Jersey,* together with several other articles on various other topics. While the articles themselves may belong to at least nine different groups, the journal itself is correctly put into the group of society publications.

I would prefer to say that there is no classification in the Current List. The arrangement of journals under 44 groups is certainly anything but classification. Such an arrangement has absolutely nothing to do with the highly detailed classification system of the Index-Catalogue. The grouping of journal names can not be more than a very rough approach at separating 1,000 titles into smaller units. The number of groups had to be limited to 44 because there was no place for a larger number on the front cover of the weekly list. The number of groups originally suggested was 71, but I doubt whether even 100 groups of journals could help much in bringing together under the proper subject the miscellaneous contents of such periodicals as the *Deutsche medizinische Wochenschrift,* the *Lyon médical* or the *Connecticut Medical Journal.*

A true subject classification of the articles themselves would cost much more than ten cents per issue. First, a classified and faultless bibliographical index would require a special staff for its preparation, with a well-paid editor who is both a linguist and a scholar, and with several typists who also know foreign languages. Moreover, the correct classification and the typing would have to wait until the end of the week, when all the references have been gathered for one issue. This would cause a delay of at least two weeks. Even then the classification should be left in a more or less rough preliminary stage because one thousand articles referring from all fields of science to the many aspects of medicine are far too few to permit their being arranged either in a sort of "catalogue raisonnée" or in an alphabet of very detailed subject headings. Also, it would be necessary often to repeat the same reference twice or three times in order to answer the needs of different specialists and to do justice to certain very complex publications. It was calculated that, even if the complex articles would not amount to more than 30 per cent. of all publications, such a weekly issue of the Current List would have to be increased to 60 or 70 pages with all the possible double, triple or multiple cross references. The cost of such a weekly issue would be about $240.00, and the yearly subscription not less than $20.00. Even then, an annual index would be still required, because to search fifty-two weekly numbers is a great waste of time.

Is it not better to pay only $5.00 and to leave the Current List as it is? Is it not better to consider it just a rough register, and not to try to boost it into the higher class of the systematic subject catalogue or of the bibliographical index? As a simple register, it is very useful as an enumeration of the contents of the latest issues of journals received by the Army Medical Library. Its only scope is to fill in the time between the issues of the printed and better classified bibliographical keys to medicine. Yet, even as a simple register, it can be used with much advantage. For instance, I am using it for collecting special bibliographies on various subjects I am personally interested in. As soon as the weekly issue comes to my hand, I read it through from Anatomy to group Zoology and mark all the articles I should like to see immediately or in the future. It is then the task of my assistants to copy the marked titles for my personal card file with the exact reference either to the column number of the Current List or to the original itself. The same method could be adopted by any one having the Current List. Indeed, every one should prepare his own bibliographical subject file from this rough weekly register. Bibliographical search being an integral part of research itself, the Current List should never aspire to become more than a rough register, a source left unclassified and undisturbed to be searched intimately and personally by the scientist.

A few more words on the supplementary lists of Recent Book Acquisitions. Such lists have been issued for the last four years by the library in a mimeographed circular, and mailed to other libraries and institutions for the primary purpose of facilitating interlibrary loans, thereby reducing the inquiries as to the holdings of this library to a minimum. The lists served this purpose well, and they are still chiefly for the use of libraries. Individual scholars perhaps would like to have annotated lists of medical books to show them what is trash and what is treasure. Such lists can never be expected from a public institution because annotations with recommendation or condemnation would reduce the library to the rank of the advertising agencies. The list of books is still prepared by the library, which now receives 150 copies to be mailed out gratis to other libraries. The books are arranged under 71 different subjects, and this number was found sufficient to deal with all types of books which the Army Medical Library has received so far. Since each independent publication is individually catalogued, the list includes more than 90 per cent. of the acquisitions. What is left out is of little importance, belonging rather into the class of reprints (many German theses, typewritten theses, etc.).

With this explanation, I believe that the Current List can take its correct place among the bibliographical tools of medicine, and I hope that nobody will expect more from it than what it can offer to the scholar; that is, an almost up-to-date privately published simple register of a conglomerate of journal articles received by a single large medical library and arranged in some rough groups of journals, with no attempt at a systematic classification or proper indexing of subjects.

CLAUDIUS F. MAYER,
Editor of the Index-Catalogue
ARMY MEDICAL LIBRARY

THE DUPLE: A LOGARITHMIC UNIT

To the current number of *The Mathematical Gazette*[1] I have contributed a little homily on numeration and mensuration entitled "Octonaria" which adumbrates the advantages of reckoning by eights rather than in the scale of ten. These are sufficiently manifest to need no elaboration, but there is a cognate matter which also merits consideration—the question of logarithmic units, which was raised ten years ago by Dr. A. H. Davis.[2]

It will be recalled that Dr. Davis proposed that a 10-fold change in any quantity should be called a change of one *brig*, a unit which he subdivided to obtain a more convenient *decibrig*. That these units have not become current may perhaps be ascribed not only to the fact that the brig itself is rather large but also to the somewhat involved conception inherent in the decibrig.

In this matter there may be some advantage in being practical and making more use of the simple scale of two: an appropriate name for a binary change would help and the suggestion is now made that the necessary connotation be given to the word *duple* and that the portmanteau-word *toottha*[3] might be legitimatized. Eight-fold is 3-duple and a 16-fold change or difference a change of 4 duples. In terms of acoustic intensity, one duple equals 3.01 "decibels": an increase of 15 "phons" is a 5-duple change in loudness.

The readier appreciation of values expressed in the scale of two, which familiarity would engender, might prove helpful in more worldly matters, in the purchase of a horse, for example. In terms of the usual farthing for the first shoe-nail,[4] two farthings for the second, and so on to the twenty-fourth nail, the price in farthings amounts to toottha 24 less one, that is £17,476 5s. 3¾d., and a bargain for King Richard.[5]

The annexed table of toottha will be recognized by

[1] P. Simple, *Mathematical Gazette*, October, 1941.
[2] A. H. Davis, *Phys. Soc.*, 1931, *Report of a Discussion on Audition*, p. 136.
[3] Toottha = *two to the* power of.
[4] Oliver Lodge, "Easy Mathematics," London, 1905, p. 155.
[5] Will Shakespeare, "Richard III," London, 1597.

TOOTTHA

	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	1	1.07₂	1.15	1.23	1.32	1.41	1.52	1.62	1.74	1.87
1	2	2.14	2.30	2.46	2.64	2.83	3.03	3.25	3.48	3.73
2	4	4.29	4.60	4.92	5.28	5.66	6.06	6.50	6.96	7.46
3	8	8.57	9.19	9.85	10.6	11.3	12.1	13.0	13.9	14.9
4	16	17.1	18.4	19.7	21.1	22.6	24.3	26.0	27.9	29.9
5	32	34.3	36.8	39.4	42.2	45.3	48.5	52.0	55.7	59.7
6	64	68.6	73.5	78.8	84.4	90.5	97.0	104	111	119
7	128	137	147	158	169	181	194	208	223	239
8	256	274	294	315	338	362	388	416	446	478
9	512	549	588	630	676	724	776	832	891	955

financial experts as showing compound interest; at £7 3s. 6½d. per cent., money doubles itself every ten years, and in a century increases a thousand-fold.

Tootha makes light of astronomical figures: even the number of electrons in the universe amounts only to some toottha 262.8, a figure now shown as $2^{262.8}$ but which might with some advantage be written $2\backslash 262.8$ or, even more simply, $\backslash 262.8$. Curiously enough, the universe itself seems more within our grasp when we reckon its diameter, not by the thousandmillion light-years, but as $2\backslash 74.2$ miles.

PETER SIMPLE

ENGLAND,
OCTOBER, 1941

ORIGIN OF THE JAPANESE WALTZING MOUSE

IN 1912 Fortuyn[1] pointed out that the Japanese waltzing mouse was smaller, and had a shorter tail with a lower number of tail-rings, than European *Mus musculus*. Being quite unfamiliar with the species of Asiatic wild mice, he asked for the advice of the late Oldfield Thomas, of the British Museum, and was told that the only wild mouse of this type occurring in eastern Asia was *Mus musculus wagneri* Eversmann, at that time called *Mus wagneri*, and regarded as a species different from *M. musculus*. As Fortuyn was convinced that the Japanese waltzer was derived from a type distinct from the European house-mouse, he accepted this information as the basis of his contention that the derivation of the waltzer from *wagneri* was a proven fact.

More recently W. H. Gates[2] has supported Fortuyn's view, and has adduced morphological and physiological, as well as historical facts in its favor. Keeler,[3] primarily on historical grounds, has maintained a south Chinese origin of the waltzer.

Through the kindness of Dr. G. M. Allen, of Cambridge, Mass., I have recently had an opportunity to examine specimens received from Dr. Fortuyn, including 24 waltzing mice (8 white, 8 black, 8 Dutch piebald), and 9 wild *wagneri* from Peking, China. They bear out the resemblance between the two types, as described by Fortuyn and Gates. Therefore, it can be taken as proved that the Japanese waltzer has nothing to do with the European house-mouse.

However, the evidence that these mice were first bred in China, and were taken to Japan later on, can not be accepted as conclusive for the following reasons.

(1) *M. m. wagneri* Eversmann is not the only wild race of short-tailed mice of this group, found in eastern Asia. A second wild subspecies, *M. m. manchu* Thomas (1909),[4] is found in Manchuria and Japan. *Wagneri* and *manchu* are very closely related, but in populations of *manchu* a buff, and a dark grey color phase are found, whereas in *wagneri* only the buff phase is known.

(2) The Japanese house-mouse, *M. m. molossinus* Temminck, is derived from the local wild stock of *M. m. manchu*, from which it differs by its small size, and in having the belly buffy, instead of white. It has the same two color phases as the wild stock, the buffy and the dark grey, and almost as short a tail. When Thomas gave his information to Fortuyn, he was not aware of the occurrence of *M. m. manchu* in Japan, nor of the fact that *molossinus* was the common Japanese house-mouse, and that in Japan the European house-mouse does not exist.

(3) The house-mice of southeastern China, as far north as the Yangtze River, belong to the Indian type. They have very long tails, much longer than the head and body. They closely approach the European style, but differ widely from the short-tailed Japanese house-mouse.

(4) No true house-mice occur in northern China. The house-mice there are facultative commensals, and do not differ considerably from the local wild *wagneri*.

(5) The Japanese waltzer agrees in size and tail-length with the Japanese commensal *M. m. molossinus*. There is no need to suppose that it has been taken to Japan from elsewhere. It can not have been bred in northern China, where no true commensal mice are found, nor can it be derived from the house-mice of southern China, from which it is widely different.

ERNST SCHWARZ

U. S. NATIONAL MUSEUM

[1] A. B. D. Fortuyn, *Zool. Anz.*, 39: 88, 1912.
[2] W. Gates, Carnegie Inst. Washington, Publ. 337: 91, 1926.
[3] C. E. Keeler, "The Laboratory Mouse. Its Origin, Heredity and Culture." Cambridge, Mass., 1931.
[4] O. Thomas, *Ann. Mag. Nat. Hist.*, (8) 4: 22, 1909.

SCIENTIFIC LITERATURE

GROWTH OF PRIMATE LITERATURE SINCE 1800

IT is only within the past decade or two that the study of the primates as a distinct zoological group has come into sufficient stature to warrant separate designation—"primate biology" or if you will, "primatology." That such a cleavage is not merely a terminological one is witnessed by the fact that individual workers and even whole laboratories are almost exclusively devoted to the study of this order. Nor does the interest in the primates lie only in their rôle as man's unhappy vicar in laboratory experimentation. Rather is the interest broader and more truly biological.

The drawing together of the literature of the primates,[1] in three of its phases, anatomy, physiology and psychobiology, affords an opportunity to survey the present status and the development of primate biology by analyzing the collective literature with respect to time, subject, place of publication, etc. Perhaps the most striking thing of all is the restricted character of the literature. Extensive searching yielded some 4,630 articles or books relating to the anatomy, physiology and behavior of the primates published prior to the beginning of 1939. In this number are counted many works in which representative primates are treated along with others of the mammalian or vertebrate series, and in certain sections many "popular," anecdotal and descriptive papers are included. This whole literature represents but a fraction of attention devoted to almost any other group of animals. Man, so often self-accused of anthropocentricity, does not in his zoological interests show any intense preoccupation with his next of kin.

Another fact which emerges without analysis is the not unexpected preponderance of morphological over functional studies. Classified as anatomical (*i.e.*, systematic anatomy, embryology, histology and studies employing the techniques of physical anthropology) are 2,734 titles or 59 per cent. of the whole (4,630); as physiological and pharmacological, 896 or 19 per cent.; and as psychobiological 669 or 14 per cent. The latter should perhaps be broken down as is done in the bibliography into experimental and observational psychobiology, the former numbering 316 papers or 6 per cent. The remaining papers were published before 1800 or fall under the category of miscellaneous bibliographies, which include such topics as "phylogeny of the primates," "primate culture and methodology," "the primates in mythology," etc. One reason for the preponderance of structural studies lies certainly in the relative unavailability of living primate forms in adequate quantities for functional studies. Another without doubt is historically grounded, and is brought out by graphing the number of papers appearing in each subject per year. It is quite clear from this graph that the three subjects got underway in the order of anatomy, physiology and psychobiology. Morphological studies show a steady increase in number except for the years marred by the first World War, with, perhaps, a tendency for slower growth in the past fifteen years. Physiological studies made a rather definite beginning in the last decades of the nineteenth century, due no doubt to the English and German

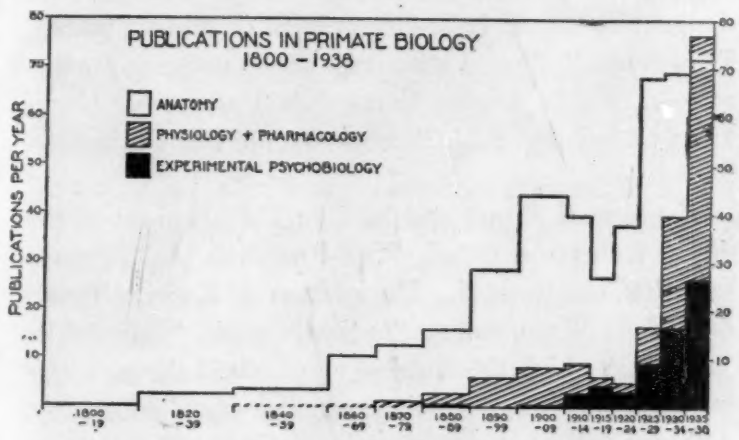


FIG. 1

investigations of the nervous system. A steady though not accelerating interest was exhibited in primate physiology until well after the war. Beginning about 1930 has come a remarkable increase in the number of physiological papers, until functional and morphological studies become roughly equal. Experimental psychobiology though later in starting (*c.* 1910) parallels in growth its fellow functional science.

It is interesting to speculate on the factors determining the growth of these subjects. Does the plateauing of anatomical studies in the past decade and a half denote simply a maturing of a subject? Or does it reflect a change in the attitude of anatomists from a comparative to a functional approach, causing him to be recruited into the ranks of the physiologists? The many important contributions to the physiology of the nervous and endocrine systems coming from anatomical laboratories in recent years are indicative

[1] T. C. Ruch, "Bibliographia primatologica: A Classified Bibliography of Primates Other Than Man. Part I. Anatomy, embryology and quantitative morphology; physiology, pharmacology and psychobiology; primate phylogeny and miscellanea." xxvii + 241 pp. Springfield, Ill.: Charles C Thomas, 1941.

of some such process. Though the literature has not been analyzed from this point of view, the burst of activity in physiological and psychobiological investigation coming in the past decade must in some degree reflect the stimulus afforded by the creation of laboratories for primate research by the foundations.

The break in the orderly march of these subjects occasioned by the war and extending well into the post-war years, is cause for speculation on the course these graphs will take in the next five-year period.

T. C. RUCH
J. F. FULTON

LABORATORY OF PHYSIOLOGY,
YALE UNIVERSITY SCHOOL OF MEDICINE

SOCIETIES AND MEETINGS

THE TENNESSEE ACADEMY OF SCIENCE

THE forty-ninth meeting of the Tennessee Academy of Science was held in Nashville on November 28–29, at the George Peabody College for Teachers. President F. L. Wren presided. Friday and Saturday mornings were devoted to general sessions, with Friday afternoon reserved for sectional meetings. Fifty papers were presented.

The following chairmen presided at the section meetings on Friday afternoon: *Botany:* D. M. Brown, State Teachers College, Johnson City; *Geology and Geography:* R. A. Laurence (for B. C. Moneymaker), Tennessee Valley Authority, Chattanooga; *Mathematics:* W. L. Miser, Vanderbilt University, Nashville; *Chemistry:* L. J. Bircher, Vanderbilt University, Nashville.

The annual dinner was held on Friday night at the James Robertson Hotel. Vice-President D. M. Brown served as toastmaster. The address of Retiring President F. L. Wren was on the timely topic, "Our Public Trust," in which the speaker emphasized the new role and responsibility of science in the world of to-day. A beautifully colored motion picture, "The Sportsman's Dollar," was shown by the courtesy of the Educational Service of the State Department of Conservation.

At the meeting of the executive committee on Friday and at the general business session on Saturday, the following business was transacted: (1) A committee appointed to proceed in the organization of a Junior Academy of Science. (2) A committee appointed to canvass the state to determine the number and type of science groups with the possibility of offering student membership in the academy at a reduced rate. (3) Jesse M. Shaver was elected representative of the academy on the Council of the American Association for the Advancement of Science. (4) Recommendations will be made to the incoming executive committee that in place of the regular spring meeting the academy convene with the newly organized Southern Association for the Advancement of Science.

New officers for 1941–42 were elected as follows: *President:* D. M. Brown, State Teachers College, Johnson City; *Vice-President:* C. S. Shoup, Vanderbilt University, Nashville; *Secretary-Treasurer:* Kendall E. Born, State Division of Geology, Nashville. *Section Chairmen: Botany:* Frances Ranney Bottom, George Peabody College for Teachers, Nashville; *Geology and Geography:* Robert A. Laurence, Tennessee Valley Authority, Jefferson City; *Mathematics:* J. A. Cooley, University of Tennessee, Knoxville; *Chemistry:* C. A. Buehler, University of Tennessee, Knoxville.

KENDALL E. BORN,
Secretary-Treasurer

SPECIAL ARTICLES

A NEW PROTEASE FROM BROMELLA PINGUIN L.[1]

THE juice obtained from the fruit of the *Bromelia pinguin* L., commonly called "maya" in Puerto Rico, has a pleasantly acid taste, but produces a burning sensation when applied to the hand or lips, peeling the skin after a few hours.

Suspecting the presence of a proteolytic enzyme in this juice, it was tested by the milk-clotting method of Balls and Hoover,[2] as well as by the formol titration, using gelatin as a substrate. Similar tests were performed on heat-inactivated juice which served for control tests. The result of these trials is reported in Table I, which shows the presence of a protease in the juice.

To obtain the crude enzyme, 100 cc of fresh maya juice were filtered with celite. To the filtered juice

TABLE I

Juice	pH	Milk clotting units per cc of juice*	Formol titration. cc 0.01N NaOH per cc of juice
Fresh	4.0	50	3.80
Boiled	4.0	No clotting	1.10

* A milk-clotting unit is defined here as the amount of enzyme preparation required to clot 5 cc of standard milk solution from dried milk in one minute at 40° C.

[1] Published with the approval of the director of the School of Tropical Medicine and of the director of the Agricultural Experiment Station of the University of Puerto Rico. A cooperative project.

[2] A. K. Balls and S. R. Hoover, *Jour. Biol. Chem.*, 121: 737, 1937.

pH 4.0, 300 cc of acetone were added and the precipitate obtained, separated by centrifugation. The precipitate was dissolved in 100 cc of 0.02 M NaCN and then reprecipitated by the addition of another 300 cc of acetone. This last precipitate was washed with acetone and ether and then placed in a vacuum desiccator over $CaCl_2$. The dried precipitate was pulverized in a porcelain mortar until a fine, whitish powder was obtained. The yield of crude enzyme was 5 gm.

The activity of this preparation, when in solution at a pH 5.9, is of 390 milk-clotting units per gm. This enzyme is a typical papainase, as it is reversibly inactivated by H_2O_2 and iodine, and activated by NaCN and cysteine. Like other papainases, this enzyme digests live tissue. *Macracanthorhynchus hirudinaceus* (from hog intestine) were digested by a 1 per cent. solution of our enzyme preparation in less than 12 hours, when incubated at 40° C at pH 5.5. Controls in the same solution, previously boiled, were not digested.

The amount of crude enzyme that can be recovered from maya juice is a little over 17 times the amount of bromelin obtained from the average pineapple juice. Both enzyme preparations have about the same milk-clotting activity, therefore the maya may prove, in the future, to be an important source of a papain-like enzyme.

Having found in the available literature no account of this enzyme, we submit this brief report, which will be followed in due course by a more complete description, and suggest the name "pinguinain" for this new enzyme, as the generic name of the plant source has already been used in naming bromelin, the enzyme obtained from the pineapple.

CONRADO F. ASENJO
M. DEL C. CAPELLA DE FERNANDEZ
SCHOOL OF TROPICAL MEDICINE AND
AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF PUERTO RICO

PARTICULATE GLYCOGEN*

BY fractional centrifugation of finely dispersed liver suspensions a submicroscopic particle containing glycogen was obtained. This particle has an approximate sedimentation constant of $4{,}000 \times 10^{-13}$. This means a particle size much larger than the tobacco mosaic virus, which has a molecular weight of 15–20 million and a sedimentation constant of $191\text{–}239 \times 10^{-13}$.[1] The particle is stable at 37° C. but can be dispersed by heating at 100° C. for several hours. It may also be dispersed by trichloracetic acid or potassium hydroxide. The dispersed glycogen can not be separated at 12,000 r.p.m.; this is the speed used to separate the original particle. According to Oakley and Young,[2] glycogen separated by the usual methods has a molecular weight of only two million. Clearly, then, particulate glycogen is an aggregate of smaller glycogen units.

The particle contains a high percentage of water; however, practically all the dried residue is glycogen. The dried particle also contains about 1 per cent. protein. This protein may play an important role in the maintenance of the particle, inasmuch as all the agents which disperse the particulate glycogen markedly alter the protein. None of these is thought to alter the properties of glycogen.

It is clear that, if this protein, or some other agent, combines with the dispersed glycogen as the latter is synthesized in the liver cell the glycogen will be removed from solution. By the law of Mass Action the enzymatic reaction

$$\text{Glucose–1–phosphate} \rightleftharpoons \text{Glycogen} + \text{Phosphate}$$

would be shifted in favor of glycogen synthesis, therefore facilitating glycogen storage in the liver. The concentration of glucose in the liver cell would be diminished. This would favor the removal of glucose from the blood stream and a consequent lowering of blood sugar.

The action of this coacervating agent, which may be protein, seems to parallel the action of insulin, because insulin is known to lower blood sugar and facilitate glycogen storage in the liver. The relationship, if any, between the protein contained in particulate glycogen and insulin is being investigated.

I should like to express my deep appreciation to Professor R. R. Bensley for his suggestions, criticisms and constant encouragement.

ARNOLD LAZAROW
UNIVERSITY OF CHICAGO

AN UNIDENTIFIED VIRUS WHICH PRODUCES PNEUMONIA AND SYSTEMIC INFECTION IN MICE[1]

IN the course of attempts to isolate viruses by direct inoculation of albino Swiss mice with throat washings from clinical cases of influenza, non-influenzal pneumonias were frequently encountered in the passage mice. The pneumonias observed were of two types. One type was grossly indistinguishable from that produced by influenza virus, and the etiological agent of this type was found to be a filtrable virus

* This work was aided by a grant from the Dr. Wallace C. and Clara A. Abbott Fund of the University of Chicago.

[1] Erriksson-Quensel and Svedberg, *Jour. Am. Chem. Soc.*, 58: 1863, 1936.

[2] Oakley and Young, *Biochem. Jour.*, 30: 868, 1936.

[1] These investigations were financed largely by a grant from the International Health Division of the Rockefeller Foundation.

which was subsequently identified, on the basis of serological reactions, with that described by Horsfall and Hahn.[2] Dochez, Mills and Mulliken[3] and Gordon, Freeman and Clampit[4] have described similar pneumonia-producing viruses isolated from apparently normal mice. The second type of pneumonia encountered was likewise found to be due to a filtrable virus, but the microscopic demonstration of elementary bodies, the characteristic appearance of the early lesions,[5] the greater virulence and the serological reactions definitely distinguished this virus from the former.

Three strains of this virus were isolated from mice during the course of serial lung passages initiated with throat washings from three different cases of clinical influenza. Two strains were subsequently isolated from apparently normal mice in the course of serial lung passages initiated with the lungs of uninoculated mice. These five strains of virus were apparently identical.

The etiological agent was found to pass through a Berkefeld N filter. When stained with Giemsa, Castaneda and Macchiavello stains, virus particles of variable morphology, similar to those described for psittacosis and lymphogranuloma venereum, were demonstrable.

The virus was readily cultivated by the method of Cox[6] in the yolk sac membrane of the developing chick embryo, the morphological characteristics of the cultivated virus being in every way identical with those seen in lung preparations from infected mice.

The earliest pulmonary lesions observed in mice consisted of scattered pinpoint raised gray focal lesions. With progression of the infection these lesions coalesce to produce complete pulmonary consolidation grayish red in color. Intranasal inoculation of 0.05 cc of a 10^{-1} suspension of infected mouse lung kills mice within 24 hours.

Upon intracerebral inoculation of mice, the virus was recovered from both brain and lungs but could not be passed serially from brain to brain. Upon intranasal inoculation, virus was recovered from the lungs and spleen but not from the brain. These observations indicate both pneumotropic and viscerotropic properties.

A more complete presentation of the study of this virus will appear in a subsequent publication.[7]

CLARA NIGG

INFLUENZA RESEARCH LABORATORY,
MINNESOTA STATE DEPARTMENT
OF HEALTH,
MINNEAPOLIS

SCIENTIFIC APPARATUS AND LABORATORY METHODS

COMPUTING SCALES FOR CALCULATING PERCENTAGE DEVIATION FROM AVERAGE WEIGHT[1]

THE accompanying scales were set up to calculate the percentage by which a man of specified age, height and weight differs in weight from the average of accepted white male life insurance applicants of the same age and height.[2] To use these scales, first set a pair of dividers on the appropriate rulings on the left-hand scale. These rulings have been so calibrated that the span between the divider points represents the logarithm of the average weight of men whose heights and weights are specified. The dividers are then lifted; one point is placed, as illustrated, at the proper place on the weight scale, and opposite the lower point, one can read off the percentage deviation. In this operation, one subtracts the logarithm of the expected weight from the logarithm of the observed weight, obtaining the logarithm of the ratio of observed to expected weight. The lower part of the right-hand line is labeled so that the ratios can be read off directly.

The net effect is to replace three variables, height, age and weight by one new variable, percentage weight deviation. In certain statistical problems[3] this represents a useful simplification of the data. The computing scales of Fig. 1, or a slide rule described elsewhere,[4] may be used in problems in which height, weight and age are under study.

In other problems involving multiple correlation or joint correlation, it may be advantageous to make

[2] Frank L. Horsfall, Jr., and Richard G. Hahn, *Jour. Exp. Med.*, 71: 391, 1940.

[3] A. R. Dochez, K. C. Mills and B. Mulliken, *Proc. Soc. Exp. Biol. and Med.*, 36: 683, 1937.

[4] F. B. Gordon, Gustave Freeman and J. Marion Clampit, *Proc. Soc. Exp. Biol. and Med.*, 39: 451, 1938.

[5] A personal communication from Dr. Monroe D. Eaton and Miss M. Dorthy Beck has called my attention to the similarity between the elementary bodies and pulmonary lesions characteristic of this virus, the pneumonitis virus described by Eaton, Beck and Pearson (Monroe D. Eaton, M. Dorthy Beck and Harold E. Pearson, *Jour. Exp. Med.*, 73: 641, 1941) and the meningo-pneumonitis virus of Francis and Magill (Thomas Francis, Jr., and T. P. Magill, *Jour. Exp. Med.*, 68: 147, 1938).

[6] Herald R. Cox, *Public Health Rep.*, 53: 2241, 1938.

[7] Clara Nigg and Monroe D. Eaton. To be published.

[1] From the Division of Industrial Hygiene, National Institute of Health, U. S. Public Health Service, Washington, D. C.

[2] Assoc. Life Insurance Med. Dir. and the Actuarial Soc. Amer. Medico-Actuarial Mortality Investigation. Vol. I. 1912.

[3] P. A. Neal, R. H. Flinn, T. I. Edwards, *et al.*, *Public Health Bulletin* No. 263, 1941.

[4] T. I. Edwards, A slide rule and two nomograms by which the percentage deviation of a man from the average weight of men of his height and age may be calculated. *Amer. J. Hyg.* In press.

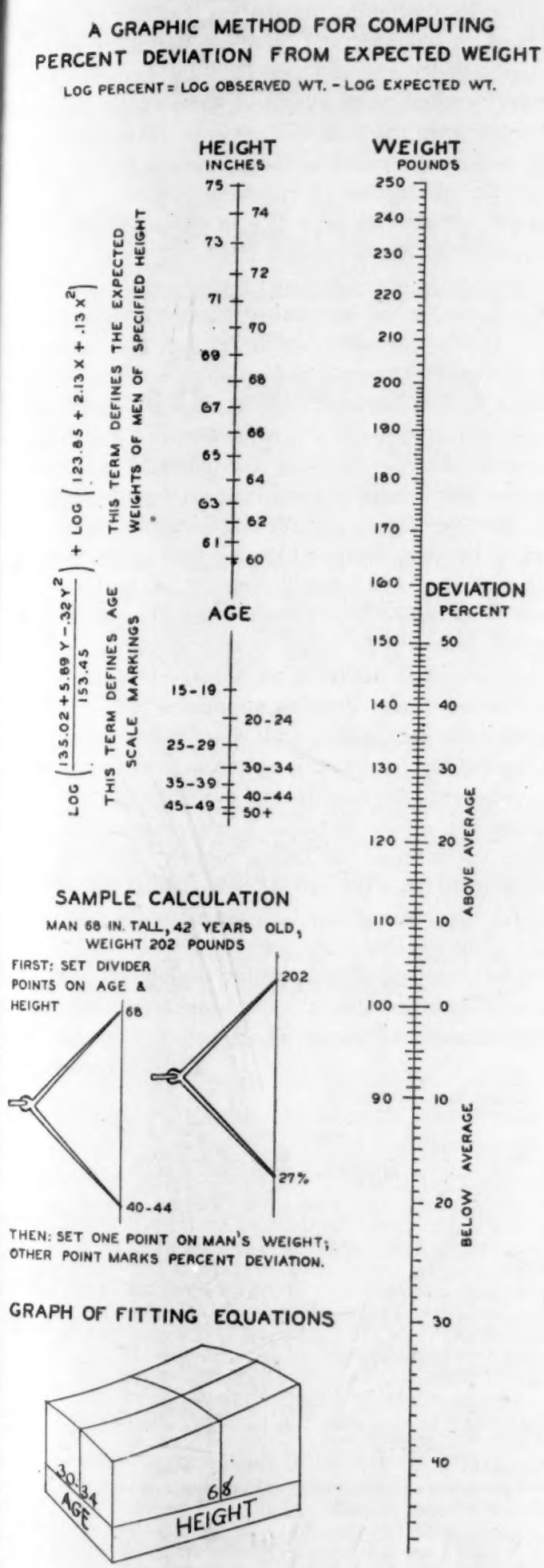


FIG. 1

allowance for an entirely different set of variables. A brief discussion of the principles on which Fig. 1 is based may be helpful to an investigator who wishes to make a similar computing device to fit his own data. No novelty can be claimed for arranging logarithmic scales so that computations can be carried out with dividers. In 1620, Edmund Gunter (1581–1626) arranged logarithmic scales so that the operations of multiplication and division could be carried out with compasses. Such scales, under the name of gunters, were used for many years by mariners. In more recent times, however, the method seems to have been neglected.

The height-weight-age data under discussion are an instance of multiple correlation. That is to say, if the relation between weight and height is determined for men aged 30–34, the same relation may be made to apply to men of any other age group by translocating the weight-height equation along the age axis. Ordinarily, translocation would be accomplished by adding certain amounts to the equation describing the weight-height relation for men aged 30–34 (or subtracting them, as the case might be). In this instance, the computing scales were meant to yield a ratio, and this made it desirable to work in logarithms throughout. The easiest way to make the weight-height relation describe different age groups was to multiply it by an appropriate factor.

The equations used to fit these data are shown in Fig. 1 and are plotted at the foot of that figure. They were obtained by the method of least squares. There were 128 average-weight values in the set of data on which these equations were based, representing 16 height classes from 60 inches ($x = 1$) to 75 inches ($x = 16$) and 8 age classes from 15–19 years ($y = 1$) to 50 years and over ($y = 8$). All but about half a dozen of these 128 average weights can be predicted to within a pound by means of these equations. The aberrant values lie in the extreme corners of the table.

In this example, the computing scales have been used to reduce three variables to the form of a ratio. This, of course, is not the only operation which can be expedited. Almost any operation involving the addition or subtraction or the multiplication or division of three variables that can be carried out on special slide rules or by other nomographic methods can be set up as computing scales, or gunters; in many instances with less labor. Before making many computations it would be advisable to protect the scales by a strip of scotch tape or some other transparent material. Dividers fitted with a fine adjustment screw are convenient.

THOMAS I. EDWARDS
NATIONAL INSTITUTE OF HEALTH

RAPID TRANSMISSION TECHNIQUES FOR STONE-FRUIT VIRUSES

THE nature of the virus diseases of woody plants, including the stone fruits, is such that without the insect vector transmission can ordinarily be effected experimentally only by grafting. The chief obstructions to progress have been: (1) the apparently long incubation periods that obtain when ordinary transmission techniques are employed, (2) the lack of adequate details on how these viruses move in their respective hosts, (3) the almost complete lack of knowledge on the identity of the insect vectors, and (4) the lack of adequate attention to the possibility of developing new transmission and indexing techniques.

In studies on yellow-red virosis in peach[1] it was found that when a simple pruning technique was employed the incubation period was reduced from approximately a year to one month. The present modified technique involves: (1) the insertion of diseased buds about midway on the stems of rapidly growing peach seedlings[2] when between 12 and 24 inches tall and (2) cutting off the stem one node above the diseased bud from 0 to 7 days afterwards to stimulate a new spurt of growth.

This rapid transmission technique has since been tested for shortening the transmission periods of a number of other stone-fruit virus diseases which go to the peach, with equally successful results. Distinctive symptoms of such peach virus diseases as rosette, rosette-mosaic and mosaic have been induced on peach seedlings within a month from budding. A new yellows disease of the sour cherry has also been found to index readily on peach seedlings by producing the distinctive symptom of rosette within three weeks from budding. Similar rapid transmissions have been obtained with still other stone-fruit virus diseases.

Other less efficient ways of shortening incubation periods were by defoliation, girdling and fertilization. A promising variation, especially useful with older plants, involved placing the diseased bud on one side of the stem between two rapidly growing young shoots, the remaining shoots having been previously removed.

Dormant stone fruits including cherries, plums and peaches may respond quickly to another technique involving the grafting of diseased scions onto heavily pruned healthy plants just as growth starts. This modification in technique has been successfully employed in shortening incubation periods of several viruses in cherries and plums. Besides whip, approach, wedge and cleft grafts, chip buds consisting of bark and sapwood have been successfully employed at times when the bark will not slip. The whip grafting technique resulted in the transmission of a disease with the production of ring-spot symptoms on sour cherry (*Prunus cerasus* L.) in the extremely short period of 14 days from grafting.

The principle of the rapid transmission technique is the stimulation in a growing plant by pruning of a new spurt of growth which attracts the virus with the prompt appearance of symptoms. The response seems to best be explained by the idea that a virus moves bodily through a plant in the food translocation stream. Contact periods for effecting passage of viruses from diseased buds into the stem require only the few days necessary for the formation of a callus bridge between scion and stock. Ordinarily they pass into the stem and move downward to the lower stem and roots in the food stream and only return to the upper part of the plant during a period of rapid growth such as occurs after passage through another dormant period. Pruning stimulates the lateral dormant buds to activity and changes temporarily the course of the translocation stream from downward to upward until the new growth can support itself. The immediate inflow of plant foods carrying the virus gives the minimal incubation period. The new spurt of growth from the lateral buds which has been induced by pruning can be likened to the stimulation at will of next season's growth.

The principle of the pruning technique would seem to be almost universally applicable in the study of the virus diseases of woody plants.

E. M. HILDEBRAND

CORNELL UNIVERSITY

[1] E. M. Hildebrand, *Contrib. Boyce Thompson Inst.*, 11: 485–496, 1941.

[2] Peach seedlings were found ideal for greenhouse studies. Batches of peach pits (southern, wild), after storage in moist peat at 5° C. (40° F.) for 10 weeks to break dormancy, were germinated in sand, transplanted to soil in 4 or 5 inch pots and ready to use at about 18 weeks from starting the dormant treatment. New batches of pits can be started at will any season of the year.

BOOKS RECEIVED

KAHN, FRITZ. *Our Sex Life.* Second edition, revised. Translated from the German by George Rosen. Illustrated. Pp. vii + 459. Alfred A. Knopf. $5.75.

When Peoples Meet. ALAIN LOCKE and BERNHARD J. STERN, editors. Pp. x + 754. Progressive Education Association. $3.50 ($2.50, PEA members).

BRIDGMAN, P. W. *The Nature of Thermodynamics.* Pp. xii + 229. Harvard University Press.

The Philosophy of Alfred North Whitehead. PAUL ARTHUR SCHILPP, editor. Volume III, The Library of Living Philosophers. Pp. xx+ 745. Northwestern University. $4.00.

MCLEAN, R. C. and W. R. IVEMEY COOK. *Plant Science Formulae.* Pp. vi + 203. Macmillan. $1.50.

Housing for Health. Papers Presented under the Auspices of the Committee on the Hygiene of Housing of the American Public Health Association. Pp. 221. The Science Press Printing Company. $1.00.

THOMAS, CHARLES ALLEN and OTHERS. *Anhydrous Aluminum Chloride in Organic Chemistry.* Number 87 in American Chemical Society Monograph Series. Pp. xiii + 972. Reinhold. $15.00.

TWO IMPORTANT NEW TEXTS
for
Physical Science Survey Courses

MATTER, ENERGY, AND RADIATION

By J. R. DUNNING and H. C. PAXTON, Columbia University. 665 pages, 6 x 9. $3.50

In this text the authors present a thoroughly modern discussion which, although dealing primarily with the materials of astronomy and physics, lays a sound foundation for a knowledge of all sciences. Here is a text that is distinctly *on* science, not merely *about* science, offering a definite departure, in organization and spirit, from the conventional survey textbook on physics. The book assumes no previous knowledge of the fields of science. It starts from simple basic ideas, building up so that any intelligent student should have a good grasp of the present state of advances in physical sciences.

The first section traces the history of astronomy in order to give the student a clear picture of the beginning, growth, and development of a science. The three sections dealing with matter, energy, and radiation reorganize the materials of physics which have traditionally been dealt with as though in watertight compartments, into logical and more fundamental order suggested by modern advances. Emphasis is placed upon the now apparent relationships between all physical phenomena.

FUNDAMENTALS OF PHYSICAL SCIENCE

By KONRAD BATES KRAUSKOPF, Stanford University. 660 pages, 6 x 9. $3.50

This distinctive book has already won a place for itself as a well-balanced and scholarly text which captures and holds the interest of the beginning student. Teachers like the book because of its completeness and balance of subject matter; the emphasis on basic principles rather than details; and the presentation of physics, chemistry, astronomy and geology as a unified field of knowledge. The achievements of modern science and important discoveries of the past are discussed with special emphasis on fundamentals and on methods of scientific reasoning.

Difficult subjects are fully explained in simple language, with a minimum of technical terms. From a pedagogical standpoint, the book is extremely flexible. It is readily adaptable to courses of different lengths, and contains sufficient materials so that a course based on the text may be varied from year to year.

Send for copies on approval

McGRAW-HILL BOOK COMPANY, INC.

330 West 42nd Street, New York, N. Y. **Aldwych House, London, W.C.2**

SCIENCE NEWS

Science Service, Washington. D. C.

ULTRAVIOLET RAYS AND VIRUS DISEASES

TESTS of ultraviolet rays as a weapon against epidemics of influenza or other virus-caused diseases that may follow the war are now under way at the Westinghouse Lamp Laboratories at Bloomfield, N. J., of which Dr. Harvey C. Rentschler is director.

In his laboratory stand row after row of test-tubes, cloudy from the pus germs growing inside them. These germs are the staphylococci that cause boils and other skin infections. When a few drops of a staphylococcus bacteriophage are poured into the tubes, the cloudiness disappears, because the bacteriophage has destroyed the staphylococci.

The staphylococci and the bacteriophage have no direct connection with influenza or colds. But they are part of the elaborate set-up devised by Dr. Rentschler to test the power of the ultraviolet rays to kill germs that cause influenza, colds, infantile paralysis and the like. These germs are viruses. Unlike the staphylococci of boils and other bacteria, the bacteriophage and other viruses can not be seen even under very powerful microscopes. Shadow pictures of them have been taken with the electron microscope, but except for these, the viruses have remained completely invisible. Yet they take a staggering toll of life in man, plants and animals.

How to tell whether you have killed or paralyzed something you can not see is part of the problem to be solved in order to test the possibility of using ultraviolet light to stop epidemics caused by these invisible agents of disease. Dr. Rentschler believes that it can be solved with the staphylococci and the bacteriophage that lives on them. Bacteriophage is a virus, although it does not attack humans. If it can be destroyed by ultraviolet rays, perhaps the rays can kill other viruses that do attack man.

You can actually see whether or not bacteriophage has been destroyed. If, after it has been irradiated with ultraviolet, it fails to clear up the cloudy tube of growing staphylococci, it seems logical to conclude that it has either been killed by the rays or at least has lost its ability to destroy the staphylococci.

Experimentally it isn't just as simple as that. Dr. Rentschler points out that chance plays a large part in such a test, for he has no idea of the number of bacteriophage particles that go into a given bacteria-infested tube. Individual drops of solution may contain one active particle, or a million. They can not be counted in an electron microscope because the electron beam probably would destroy their potency as quickly and surely as ultraviolet rays. So the only scientifically accurate approach is to make thousands of tests until observed results can no longer be attributed to chance.

GAS GANGRENE

A NEW kind of gas gangrene threatens workers in America's war industries unless care is taken to guard open cuts and wounds from magnesium splinters and dust, it appears from a report by Dr. Carey P. McCord, of t medical department of the Chrysler Corporation at D troit.

Metallic magnesium and some of its alloys, the new widely used metal in war industries, have been found produce a unique gaseous condition when they get i wounds. Unless the magnesium is properly and co pletely cleaned out of the wound, even trivial injuries m become serious and prolonged. The condition that r sults is similar to gas gangrene, a serious war wou danger, except that it is caused by the magnesium inste of by germs. According to reports received, this ki of chemical gas gangrene has been very prevalent German industries with as many as 5,000 cases in 19

The studies by Dr. McCord, Dr. Stuart F. Meek and D Gordon C. Harrold, also of the Chrysler Corporation, a believed to be the first in the United States showing t danger of not cleaning out all metal particles or dust fr a wound in which magnesium particles might be involv "Early in our investigation," Dr. McCord reported, "w found that rat wounds in which small particles of mag nesium had been introduced, unlike those contaminat with most metals, glass and wood, promptly lead to hydr gen gas formation in the tissues. The quantity of g we found to be extensive and if neglected probably wou produce a condition akin to a chemical gas gangrene. I the presence of magnesium particles it was discover that hydrogen was evolved from the fluids of the tissu themselves and if the metal was not immediately e tracted, would form a gaseous tumor. Thus it woul seem that injuries resulting from not cleaning all mag nesium particles from wounds may be much more serio than ordinary industrial injuries. The danger of th effect of magnesium calls, in the first place, for speci preventative procedure against accidental injuries whe magnesium particles might be involved, and in the se ond place, the availability of immediate proper medic care. The complete removal of all metallic magnesiu apparently is vital."

A SOYBEAN RUBBER SUBSTITUTE

INVESTIGATORS in the Department of Agriculture ho to develop a process whereby they believe soybean me can be transformed into a substitute for rubber. Th process, which for military reasons can not be describe in detail, consists of a series of chemical changes whi finally transform the protein molecules of soybean mea into molecules similar in structure to those of rubbe

"Soybean rubber," according to chemists of the bu reau, "won't come the day after to-morrow, but it's n the way. It's possible on paper."

Meanwhile soybean oil already is being substituted fo tung oil in paints. Tung oil was imported from Chin before the war, and diminishing stocks lend special em phasis to soybean substitutes.

Adhesives, plastics, paper finishes and substitute-woo fibers are other uses for soybeans—uses developed largel

by American Government and industrial chemists since 1936 when the soybean laboratory of the Department of Agriculture was set up at Urbana, Ill.

The production of a synthetic fiber from soybeans has already been begun by the Ford Motor Company. The fiber is similar to sheep's wool. It is spun from a molasses-like substance that contains soybean protein. "Pilot" mills at Highland Park, Mich., can spin 1,000 pounds of fiber daily. The Highland Park mills are being moved to Dearborn, where they will undertake regular production. The synthetic product is best when blended with sheep's wool. The soybean fiber is considerably less than half as expensive as wool.

A POSSIBLE PACIFIC NORTHWEST IRON AND STEEL INDUSTRY

CREATION of a great iron and steel industry in the Pacific northwest to provide the basic war metals now vitally needed is believed possible owing to the discovery by government geologists of rich, high-grade iron ore deposits in Kasaan Peninsula, southeastern Alaska.

The deposits are less than 600 miles from Seattle by the "inside passage" along the Canadian coast protected from submarines by off-shore islands.

With limitless power now available from Grand Coulee and Bonneville dams the Pacific northwest's dream of an iron and steel industry equal to Youngstown and Bethlehem becomes more real.

Two geologists of the U. S. Geological Survey have announced that the iron deposits on the Alaskan peninsula are far richer than even suspected. It is hoped that private industry will take the hint and send other geologists to verify their find.

Copper was mined thirty years ago on the Kasaan Peninsula, and in 1917 the area was appraised as a "possible" source of iron. John C. Reed and George O. Gates, of the survey, however, this year found the iron deposits far richer than they expected.

Their examinations appraise the iron content of the ore as high as 60 per cent. It is reported by Drs. Reed and Gates that many of the individual bodies of high-grade magnetite probably contain between 25,000 and 2,000,000 tons each, and some of the bodies may contain even more than 2,000,000 tons. These substantial deposits, if their grade holds with depth, may have national significance in connection with the large hydroelectric installations at the Grand Coulee and Bonneville power projects. The availability of large quantities of cheap electric power in the Pacific northwest area, coupled with the needs for iron and steel of the war machine, focuses attention of expanding industrialization not only on the Kasaan deposits, but also on similar deposits on Texada and Vancouver Islands, British Columbia, and in the vicinity of Copper Mountain, Prince of Wales Island, Alaska.

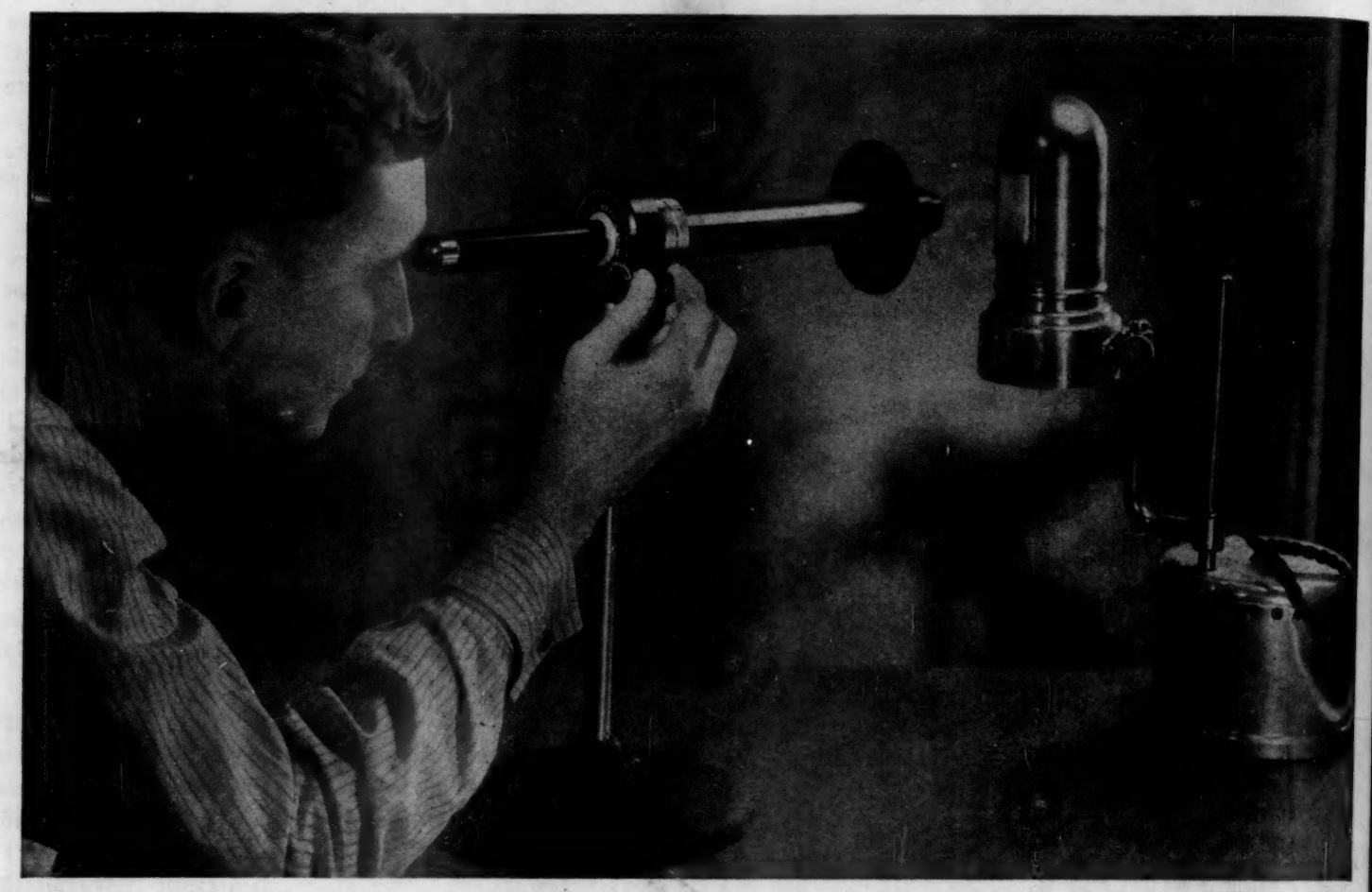
ITEMS

STOCKPILES of rubber and other strategic materials should be maintained after the war as well as during the war and the United States government should immediately appropriate $100,000,000 for the development of synthetic rubber, was pointed out by Dr. Harry N. Holmes, head of the department of chemistry of Oberlin College, on assuming office as president of the American Chemical Society. "Many contend," he continued, "that we are promised free access to raw materials all over the world when peace comes. But treaties have been broken before and we must not again be caught napping."

ON the "scorched earth policy," the glaciers which invaded North America a million years before the birth of Christ could teach even the Russians a thing or two, according to a report that Professor R. F. Flint, of Yale University, made at the Boston meeting of the Geological Society of America. Whereas the Soviets burn the standing crops on the rich soils of Russia, the great ice fields took along the soil itself down to bed rock. Dr. Flint described to the meeting the first glacial map of North America, a cooperative scientific venture directed by twelve American geologists and four Canadians. Each inch on the map represents 60 miles and the vast area covered by the finished map will require seven feet from north to south.

A DEVICE which allows double-quick counting of stars on a photographic plate has been successfully tested and used at the Warner and Swasey Observatory at Cleveland. Dr. S. W. McCuskey reported on the use of this instrument before the meeting of the American Astronomical Society. His instrument counts stars as faint as the fifteenth magnitude, regardless of the number of stars on the plate. At present, the machine counts are made by an observer who places each star image in the sensitive beam of the photometer. Thus far completely automatic scanning of the plate has not yielded results accurate enough for statistical purposes. The rate of counting, including the necessary calibration and setting, is about 2,000 stars per hour. A run over a given area of the plate results directly in the number of stars brighter than four arbitrarily chosen magnitude intervals.

STUDENTS born in the spring are taller, heavier and smarter than those born during summer, a survey published in the December issue of *Human Biology* appears to indicate. The survey concerned 10,005 students of the University of Cincinnati, born between the years 1904–1921, inclusive. It was conducted by Dr. Laurence B. Chenoweth and Richard G. Canning of the Student's Health Service. The study also showed that students are taller than those of just two decades ago. The average height of freshmen in the University of Cincinnati in 1916 was 67.5 inches—in 1936 it had increased to 69.9 inches. Since 1936 there has been no increase in the average size of freshmen students at the university. Not only has the size of man increased, the scientists say, but children are growing more rapidly. This increase in size and rate of growth is explained by Dr. Chenoweth and Mr. Canning by decreased communicable disease, better food, knowledge of vitamins and generally improved living conditions during the last half-century.



A New, Moderate-Priced POLARIMETER

. . . with Lippich Half-Shade Polarizer

FOR teaching polarimetry, for routine laboratory work and for research in certain fields, Spencer has developed a new, moderately priced Polarimeter.

The highly desirable characteristics of the Lippich triple-field, half-shade polarizer are achieved through the use of special Polaroid optical elements. The dividing lines are sensitive, and measurements can be made with monochromatic light of any desired wave-length. The instrument is regularly supplied with a filter for use with tungsten light.

The optical rotation of the sample is measured on an easily-read scale to one tenth of a degree. The sample chamber accommodates tubes up to 200 mm. length for general or special uses. Technicians working in the fields of bio-chemistry and in industrial organic chemistry will be particularly interested in this instrument.

FOR A FOLDER DESCRIBING THE NEW POLARIMETER, WRITE DEPT. A2

SPENCER BUFFALO U.S.A.

Spencer Lens Company

BUFFALO, NEW YORK

Scientific Instrument Division of

AMERICAN OPTICAL COMPANY

Sales Offices: New York, Chicago, San Francisco, Washington, Boston, Los Angeles, Dallas, Columbus, St. Louis, Philadelphia, Atlanta